USER'S MANUAL

EPOCH LT

Part No. 910-258

PANAMETRICS-NDT™

Nondestructive Testing Products

In accordance with European Directive 2002/96/EC on Waste Electrical and Electronic Equipment, this symbol indicates that the product must not be disposed of as unsorted municipal waste, but should be collected separately. Refer to your local Olympus distributor for return and/or collection systems available in your country

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Printed in the United States of America.

Warranty

The EPOCH LT Digital Ultrasonic Flaw Detector has been designed and manufactured as a high quality instrument. Under normal working conditions the EPOCH LT will provide long, trouble-free service.

Damage in transit - Inspect the unit thoroughly upon receipt for evidence of external or internal damage that may have occurred during shipment. Notify the carrier making the delivery immediately of any damage, since the carrier is normally liable for damage in shipment. Preserve packing materials, waybills, and other shipping documentation in order to establish damage claims. After notifying the carrier, contact Olympus NDT™ so that we may assist in the damage claims, and provide replacement equipment, if necessary. Your shipping container is re-usable and may be used in the future when returning the unit for recalibration or repair.

Olympus NDT guarantees the EPOCH LT to be free from defects in materials and workmanship for a period of one year (twelve months) from date of shipment. This warranty only covers equipment that has been used in a proper manner as described in this instruction manual and has not been subjected to excessive abuse, attempted unauthorized repair, or modification. DURING THIS WARRANTY PERIOD, Olympus NDT LIABILITY IS STRICTLY LIMITED TO REPAIR OR REPLACEMENT OF A DEFECTIVE UNIT AT ITS OPTION. Olympus NDT does not warrant the EPOCH LT to be suitable of intended use, or fitness for any particular application or purpose. Olympus NDT accepts no liability for consequential or incidental damages including damage to property and/or personal injury. In addition to our standard one year warranty, Olympus NDT also offers an optional two year warranty (call for further details).

This warranty does **not** include transducers, transducer cables, or battery. The customer will pay shipping expense to the Olympus NDT plant for warranty repair; Olympus NDT will pay for the return of the repaired equipment. (For instruments not under warranty, the customer will pay shipping expenses both ways.)

In this manual, we have attempted to teach the proper operation of the EPOCH LT consistent with accepted flaw detection techniques. We believe the procedures and examples given are accurate. However, the information contained herein is intended solely as a teaching aid and should not be used in any particular application without independent testing and/or verification by the operator or the supervisor. Such independent verification of procedures become more important as the criticality of the application increases.

For these reasons, we make no warranty, expressed or implied, that the techniques, examples, or procedures described herein are consistent with industry standards nor that they will meet the requirements of any particular application. Olympus NDT expressly disclaims all implied warranties of merchantability and of fitness for any particular application.

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Documentation Comments

1 Preface

This preface discusses the following introductory topics:

- Product Description
- About This Document
- Audience
- Scope
- Typographic Conventions
- Related Documentation
- If You Have Documentation Comments
- Revision History
- Technical Help

1.1 Product Description

The EPOCH LT is the smallest and lightest flaw detector ever offered by Panametrics-NDT™, a Business of R/D Tech Instruments, Inc. At only 2.35 pounds (1.0 kg) and 1.5 inches (38 mm) thick, the EPOCH LT offers class-leading size and weight along with the performance of a fully featured flaw detector. The EPOCH LT has been designed with the inspector in mind, and the instrument has been developed with the features that are needed for common flaw detection applications. Features include:

- New Liquid Crystal Display (LCD) with backlight for exceptional indoor and outdoor visibility, 60 Hz update rate for scanning, and long battery life.
- Array of software options including DAC, TVG, AWS, DGS/AVG, Low PRF, Curved Surface Correction, Expanded Memory, Extended Range, and Echo to Echo measurement.
- Negative Spike Pulser and 20 MHz broadband receiver for high performance and simple instrument setup.
- Numeric Datalogger with storage of up to 100 waveforms/calibrations and 2000 thickness measurements (500/10,000 with Expanded Memory option). These files can be conveniently saved using numeric entries and viewed in the EPOCH LT's datalogger screen or on a PC using the GageView Interface Program. EPOCH LT files are also fully compatible with the EPOCH 4*PLUS*, EPOCH 4, and EPOCH 4B flaw detectors.

1.2 About This Document

This document is the *Instruction Manual* for the EPOCH LT. The *Instruction Manual* describes routine tasks for operating the EPOCH LT. These tasks include operating the power supply, managing basic operations, adjusting the Pulser Receiver, managing

special waveform functions, using the gates, calibrating the EPOCH LT, managing the datalogger and data communication features, and using software options.

The information contained within this manual can be read in modular format to answer questions about how to perform specific functions. We suggest reading the entire manual at least once with your instrument in hand so that you can combine reading the descriptions and examples with the actual use of the instrument.

1.3 Audience

This document is intended for any operator using the EPOCH LT. Panametrics-NDT™ recommends that all operators have a thorough understanding of the principles and limitations of ultrasonic testing. We assume no responsibility for incorrect operational procedure or interpretation of test results. We recommend that any operator seek adequate training prior to using this equipment.

While the EPOCH LT is a continuously self-calibrating instrument, it is up to the customer to determine regulatory requirements. Panametrics-NDT offers calibration and documentation services. Contact Panametrics-NDT or your local representative with any special requests.

1.4 Scope

The following table describes the major sections in this document.

Chapter	Description	Audience
Chapter 2	Describes using different power supply options. Also describes the battery operating time, battery replacement, and battery charging.	Operators
Chapter 3	Describes the EPOCH LT interface and functions such as the keypad, screen options, screen display, and setup parameters.	Operators
Chapter 4	Describes how to adjust the pulser receiver for system sensitivity, gain reference level and scanning gain. Also describes how to use the pulser keys.	Operators
Chapter 5	Describes using the special waveform functions such as reject, peak memory, and screen freeze.	Operators

Table 1 Overview to *Instruction Manual*

Chapter	Description	Audience
Chapter 6	Describes using the available gates and gate alarms. Also describes making various thickness readings, locating flaws with and angle beam transducer, measuring signal amplitude, time-of-flight mode, and the zoom feature.	Operators
Chapter 7	Describes calibrating the EPOCH LT with a straight beam, delay line, dual element, and angle beam transducer. Also describes how to locate the Beam Index Point, verify the refracted angle beam, and calibrate for distance and sensitivity.	Operators
Chapter 8	Describes using the datalogger and data communication features such as storage capacity and memory, creating new files, saving waveforms and thickness readings, and increasing ID increments. Also describes recalling and saving calibrations and waveforms, creating memos, and editing a file.	Operators
Chapter 9	Describes various software options for EPOCH LT including Distance Amplitude Correction (DAC), Time Varied Gain (TVG), Low Pulse Repetition Frequency (PRF), Expanded Memory, Echo-to-Echo Measurement Mode, AWS, Curved Surface Correction, and Extended Range.	Operators
Appendix A	Describes EPOCH LT specifications.	Operators
Appendix B	Provides a table of the ultrasonic velocity in a variety of common materials.	Operators
Appendix C	Glossary of terms.	Operators
Appendix D	Provides the EPOCH LT part list.	Operators

Table 1 Overview to *Instruction Manual (Continued)*

1.5 Typographic Conventions

The following notes and table provide a list of the typographic conventions that appear in this document.

Warning: This information indicates danger and the possibility of personal injury.

Caution: This information indicates that equipment damage can occur.

Note: This information provides explanatory information.

Tip: This information provides helpful guidelines for easy operation.

Convention	Description
`Courier Font`	Used for file names, lines of code, names of processes, and commands.
`Heavy courier`	Used for command line user input.
Bold	Used for textual parts of graphical user interface, including menu items, buttons, toolbar names, modes, options, and tabs.
Italics	Used for screen/window names, dialog boxes and document titles.
Bold Italics	Used for emphasis.
[Bold] (Square Brackets with Bold)	Used for instrument keys on the keypad.
<*Italics*> (Angle Brackets)	With italics text, used for variable data.
→	Used for showing the next sequential step.

Table 2 Typographic Conventions

1.6 Related Documentation

The EPOCH LT works with the GageView Interface Program. For more information about this software program, refer to the following instruction manual:

- GageView Interface Program, Part Number 910-259

1.7 If You Have Documentation Comments

Panametrics-NDT is always interested in improving its documentation. We value your comments about this manual and other Panametrics-NDT documentation.

Complete the survey at the back of this manual and send your documentation comments to Panametrics-NDT by using one of the following methods:

- Send comments to Panametrics-NDT, Attention: Technical Publications
- Email us at: info@panametrics-ndt.com.

In all your correspondence, please include the title of the document, its part number, release date, and the specific section on which you are commenting.

1.8 Technical Help

Call Panametrics-NDT and ask for a sales engineer to assist you.

2 Operating the Power Supply

This chapter describes operation of the EPOCH LT using different power supply options.

Topics are as follows:

- Using AC Line Power
- Using Battery Power
- Operating Time for the Battery
- Replacing the Battery
- Charging the Battery

2.1 Using AC Line Power

AC line power is supplied via a charger/adapter, which includes a universal AC power input, so it operates with any line voltage from 100-120 or 200-240 volts AC, and with 50 to 60 Hz line frequency.

To use AC line power, follow these steps:

1. Connect the power cord to the Charger/Adapter unit and to an appropriate line power source.
2. Connect the DC output power cable from the Charger/Adapter unit to the Charger/AC adapter input jack on the top of the EPOCH LT.
3. Turn the EPOCH LT on via the front keypad.
4. Proceed with normal operation.

2.2 Using Battery Power

The Panametric-NDT™ EPOCH LT uses Nickel Metal Hydride (NiMH) batteries.

Press **[ON/OFF]** to power up the unit. After the initial status screen, the EPOCH LT proceeds to the split screen display.

A battery symbol is always present at the bottom right of the display and indicates the remaining battery charge. A completely filled battery symbol relates directly to the charge remaining on the battery. A symbol that is half filled means that the battery is 50% charged. All batteries show some rebound effects so the initial reading appears higher than the actual amount; this is temporary. A stable battery reading appears after operating for 1-2 minutes.

2.3 Operating Time for the Battery

The EPOCH LT has a nominal operating time of 6-8 hours on a full charge.

Note: It may initially take several cycles of complete charging and discharging of the battery to bring the battery to full capacity. This conditioning process is normal for (NiMH) batteries.

2.4 Replacing the Battery

Warning: The EPOCH LT Charger/Adapter is designed to charge EPOCH LT batteries only. DO NOT ATTEMPT TO CHARGE ANY OTHER BATTERIES. Doing so may cause an explosion and injury! Do not attempt to charge other electronic equipment. This will cause permanent damage.

To replace the battery, follow these steps:

1. Turn the unit over so the display is face down.
2. Loosen the four screws on the back of the unit at the bottom that secure the battery door cover.
3. Remove the battery door cover exposing the battery.
4. Remove the battery pack.
5. Unclip the battery lead.
6. Install the replacement battery by reversing these steps.

2.5 Charging the Battery

Note: Charge EPOCH LT batteries with the Charger/Adapter only.

There is no on/off or line voltage selector switch. The Charger/Adapter automatically turns on when AC power is applied. You can charge the EPOCH LT battery either internally in the unit or externally using a stand-alone charging base.

To charge the battery internally, follow these steps:

1. Plug the Charger/Adapter into an AC main line.
2. Plug the output cable directly into the receptacle on the top of the EPOCH LT.

   Turn off the EPOCH LT when charging batteries to ensure a complete charge. If the EPOCH LT is powered on while connected to an AC line, the battery will continue charging (at a slower rate).

   When the unit is powered on and connected to the charger, the battery symbol on the display will continuously cycle from empty to full to indicate the battery is charging. Once the battery reaches approximately 85% capacity, the symbol will stop cycling and remain full.

3. Charge the unit for another hour after it reaches 85% capacity, in order to achieve full capacity.

You can also charge the EPOCH LT battery outside the instrument using an external stand-alone charger. This option is available through Panametrics-NDT.

If the battery is used daily (or frequently), connect it to the charger/adapter when not in use. Whenever possible, the battery should remain connected to the charger/adapter (overnight or over a weekend), so that it achieves 100% of full charge. The battery must reach full charge on a regular basis for the proper capacity and cycle life maintenance.

Recharge discharged batteries as soon as possible after use. Give a full recharge, as described above.

Note: Never place discharged batteries in storage without the batteries having received a full recharge.

Store batteries in a cool, dry environment. Avoid long-term storage under sunlight or in other excessively hot places such as an automobile trunk. While in storage, fully recharge batteries at least once every two (2) months.

3 Managing Basic Operations

This chapter describes how to get started with basic EPOCH LT operations.

Topics are as follows:

- Powering-up
- Using the Keypad
- Summarizing Keypad Functions
- Editable Parameters Software
- Managing the Display
- Setting-up Parameters

3.1 Powering-up

Pressing **[ON/OFF]** causes an initial beep from the unit and then a series of relay clicks. The display lights up and the unit goes through a self-test for five (5) seconds.

Note: You can do a Master Reset on the EPOCH LT during power-up. Press and hold the **[ANGLE]** key and then power the unit on. Do not release the **[ANGLE]** key until the screen lights up with a **Master Reset** prompt box. Press [**OPTION**] to cancel master reset and the unit will proceed to the live screen. Otherwise, press [**ENTER**] to continue. Use the slewing keys to move the highlight bar over the desired selection:

Parameters - Resets the unit's parameters back to the factor settings
Database - Erases the EPOCH LT's memory (saved calibrations, etc.)
Parameters + Database - Completes both operations listed above

Use the slewing keys to highlight your selection and press [**ENTER**]. An X appears in the box. Press [**OPTION**] to complete the MASTER RESET and proceed to the live screen.

You can adjust the EPOCH LT's screen for maximum viewing under the harshest and most extreme lighting conditions.

To adjust the screen, follow these steps:

1. Press **[2nd F], [CAL] (CONTRAST).**
2. Use the slewing keys to position the highlight bar over the appropriate selection.
3. Use the slewing keys to adjust the setting.

   LCD Backlight: You can select to have the LCD backlight display light set on or off. The default setting for the backlight is OFF.

   LCD Contrast: Depending on sunlight conditions and temperature, you may need to adjust the contrast of the LCD to maximize screen visibility. You can slew through a wide range of adjustments to optimize the display.

3.2 Using the Keypad

The most commonly used keys on the keypad (Gain, Freeze, Save, Enter, and slewing keys) are close to your left thumb. All instrument settings can be changed while keeping the left hand in a natural position.

The keypad is grouped and color-coded according to function. The outlined section of yellow keys on the left side of the keypad is used primarily for calibrating. The separate group of grey keys on top are the function keys, designed to provide easy access to preset parameter values. The EPOCH LT also has extensive data storage features controlled by the datalogger keys at the right side of the keypad.

3.2.1 Enter Key

While you can access most functions directly via the instrument keypad, you can change all essential ultrasonic controls by using the **[ENTER]** key and one of the four green slewing keys **[↑], [↓], [←],** and **[→]**. This method provides control of virtually all instrument settings with the thumb of the left hand. Multiple presses of **[ENTER]** will toggle through each of the instrument parameters. The parameter highlights when activated. Use the **[↑], [↓], [←],** or **[→]** key to change an activated parameter value.

Press the **[ENTER]** key multiple times to toggle through the instrument settings. To move quickly through the sequence, press **[ENTER]** multiple times in succession or hold down the key to reach the desired function.

3.2.2 Direct Access Operation

Most commonly used parameters also have their own individual keys to provide direct access to the parameter setting. To use the EPOCH LT in this manner, press the appropriate key to change the parameter and then either press one of the function keys (**F1**-**F5**) to select preset values, or adjust the value using the **[↑], [↓], [←],** and **[→]** slewing keys. For example, to change the gain, press **[GAIN]**. Press **[F1]**, **[F2]**, **[F3]**, **[F4]**, or **[F5]** to select one of the preset dB steps or use the slewing keys for fine adjustments.

In some cases, the parameter appears as a second function above another key. To change these parameters, press **[2nd F]** and then the appropriate key to access that parameter.

Whenever a function is opened in the full screen display, the EPOCH LT provides prompts in the *Abbreviated Status* window directly above the A-Scan display on the left side.

3.3 Summarizing Keypad Functions

The EPOCH LT keypad includes five function keys located directly underneath the display: **[F1]**, **[F2]**, **[F3]**, **[F4]**, and **[F5]**.

When an operator accesses a parameter from the lower portion of the keypad, preset value choices are displayed at the bottom of the screen. Each preset value has a corresponding function key. For example, press **[RANGE]** to view various preset range values at the

bottom of the display. Press any one of the function keys to set the EPOCH LT's range to that displayed value.

The main keypad is laid out with functional grouping of keys for easy identification. The main keypad contains the primary operating keys of the EPOCH LT. Most parameters on the EPOCH LT can be directly accessed by pressing the appropriately labelled key. Some parameters are second functions. These can be accessed by first pressing **[2nd F]** and then the desired function. The second function is written directly above the key. For example, to access ZOOM, press **[2nd F]** and then **[RANGE]**.

Once you access a parameter, change it through one of two methods. Use the function keys to directly access preset values. Alternately, use the green slewing keys (**[↑], [↓], [←],** and **[→]**) to change the parameter in smaller increments.

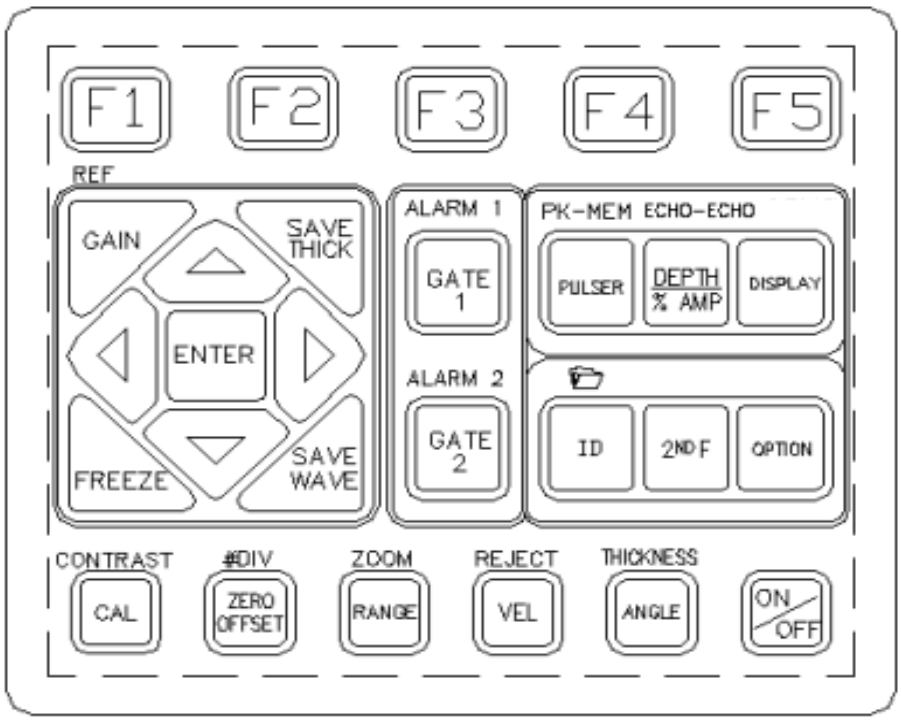


Figure 1 English Keypad

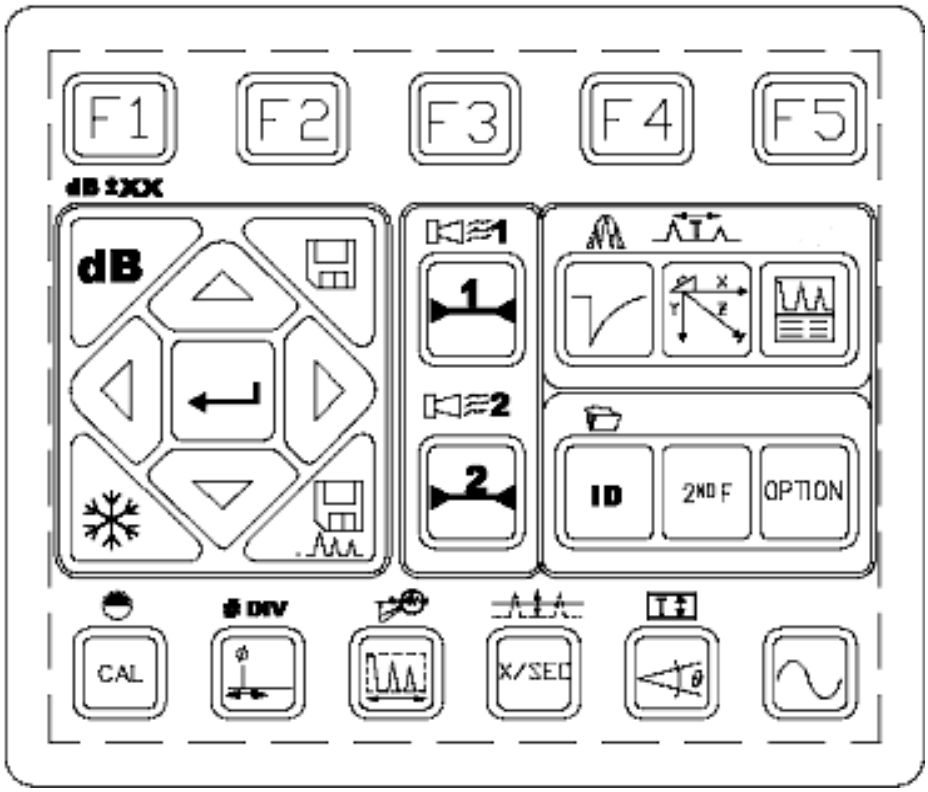


Figure 2 International Keypad

Main keypad functions include:

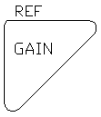
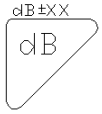
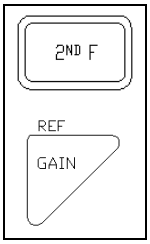
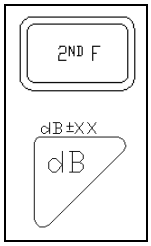
English	Int'l	Color	Function
		Blue	**Sensitivity:** Adjusts system sensitivity.
		White Blue	**Reference Level:** Sets a gain reference level and allows addition of scanning gain in 6 dB or 0.1dB increments.

Table 3 Keypad Functions

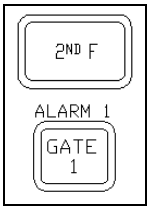
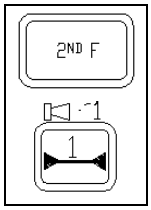
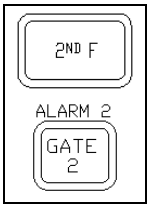
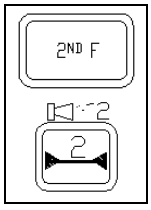
English	Int'l	Color	Function
		Blue	**Screen Freeze:** Holds displayed waveform until **[FREEZE]** is pressed a second time.
		Purple	**Save Thickness Reading:** Saves displayed thickness reading in current file. If the EPOCH LT is in **Time-of-Flight** mode, the value will be in microseconds.
		Purple	**Save Waveform:** Saves the current waveform and instrument setup parameters in current file.
		Purple	**Enter:** Press this key multiple times to toggle through the setup parameters.
		Red	**Gate 1:** Controls the positioning of Gate 1 on the display. Press this key multiple times, or use the function keys, to access Gate 1 Start, Gate 1 Width, and Gate 1 Level.
		White Red	**Gate 1 Alarm:** Activates the alarm mode for Gate 1. Use the function keys to access the Threshold or Minimum Depth Alarm.
		Red	**Gate 2:** Controls the positioning of Gate 2 on the display. Press this key multiple times, or use the function keys, to access Gate 2 Start, Gate 2 Width, and Gate 2 Level.
		White Red	**Gate 2 Alarm:** Activates the alarm mode for Gate 2. Use the function keys to select the Threshold or Minimum Depth Alarm.

Table 3 Keypad Functions (Continued)

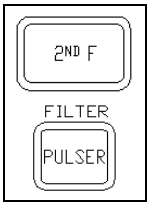
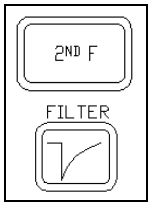
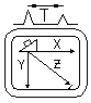
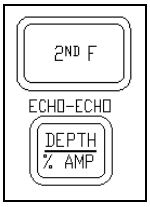
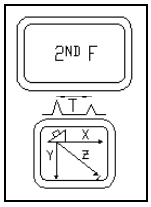
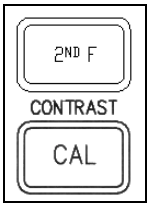
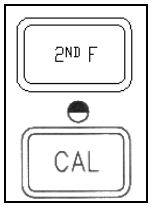
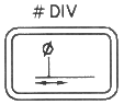
English	Int'l	Color	Function
		Orange	**Pulser:** Press this key multiple times to toggle through the pulser parameters. Use the function keys to select preset values for each pulser parameter.
		White Orange	**Peak Memory Function:** Activates the Peak Memory function allowing continuous accumulation of peak envelope data with the live waveform. Press this key again to deactivate the function.
		Orange	**Display View:** Press this key multiple times to toggle between Full Screen View (full A-Scan display) and Split Screen View (half sized A-Scan with setup parameters).
		Orange	**Depth/% Amplitude:** Allows selection and display of peak depth, edge depth, signal amplitude, or time of flight data.
		White Orange	**Echo-to-Echo Measurement:** Activates the **Echo-to-Echo Measurement** mode. This automatically opens Gate 2 (if it is not already active) and allows you to select edge to edge or peak to peak measurement using the function keys.
		Yellow	**Auto Calibration:** Initiates the EPOCH LT Auto Calibration feature in conjunction with the **[ZERO OFFSET]** and **[VELOCITY]** keys.
		White Yellow	**Contrast Adjustment:** Adjusts the contrast and backlight for units with a Liquid Crystal Display (LCD).
		Yellow	**Zero Offset:** Compensates for the time difference between the electric zero point (the time when the pulse is first generated) and the acoustic zero point (the time when the sound energy enters the test material.)

Table 3 Keypad Functions (Continued)

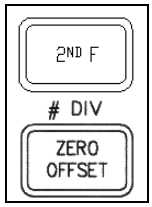
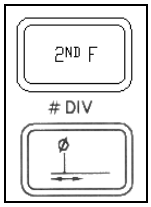
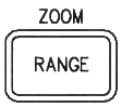
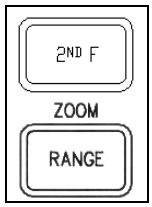
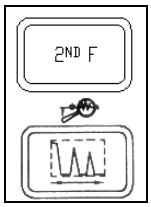
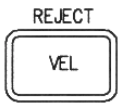
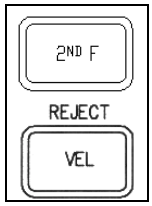
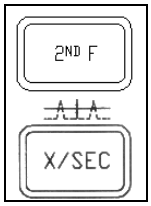
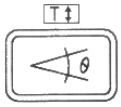
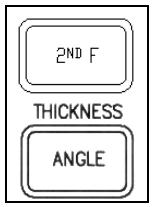
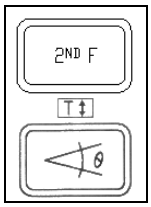
English	Int'l	Color	Function
		White Yellow	**# Div (Graticule Display):** Displays the grid numbers along the bottom of the EPOCH LT display in **Full-Screen** mode. These numbers are sometimes blocked by the function key presets.
		Yellow	**Range:** Sets the amount of sound travel time that is viewed on the display in units of material travel distance. Use the function keys to select preset values and the slewing keys to fine tune this setting.
		White Yellow	**Zoom:** Expands the screen area covered by Gate 1 to full-screen width for higher resolution viewing of portions of the waveform.
		Yellow	**Velocity:** Sets the velocity of sound in a test material for distance calculations. Use the function keys to select preset values and the slewing keys to fine-tune this setting.
		White Yellow	**Reject:** Removes low level noise and/ or signal from the waveform being viewed on the display. Use the function keys to select preset values and the slewing keys to fine tune this setting.
		Yellow	**Angle:** Allows the entry of the refracted angle of sound energy in a test piece when using angle beam transducers. Use the function keys to select preset values and the slewing keys to fine tune this setting.
		White Yellow	**Thickness:** Allows the entry of material thickness for the test piece when using angle beam transducers. Use the function keys to select preset values and the slewing keys to fine tune this setting.

Table 3 Keypad Functions (Continued)

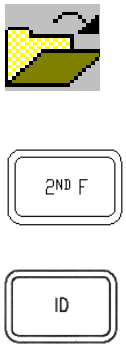
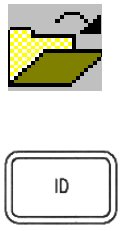
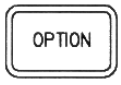
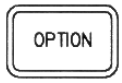
English	Int'l	Color	Function
		Blue	**ID Entry:** Allows entry of an ID (Identifier) location code. This ID could be a new location code or a current one.
		Blue	**Open Datalogger:** Opens the EPOCH LT datalogger/memory screen.
		White	**Option:** This menu allows the user to access the EPOCH LT's main setup menu. This menu contains selections for language, units, software functions, etc. Pressing the **[OPTION]** key again exits the menu and returns the EPOCH LT to the live screen.
		Green	**ON/OFF:** Turns the EPOCH LT on or off.

Table 3 Keypad Functions (Continued)

3.4 Editable Parameters Software

The Editable Parameters feature lets you customize some of the values that appear above the **[F1]** to **[F5]** keys. These are the values that the EPOCH LT recalls automatically when the corresponding **[F]** key is pressed. You can edit the following parameters:

- Gain
- Reject
- Zero Offset
- Angle
- Frequency
- Range
- Thickness
- Velocity

Note: Parameters that contain text, such as Rectification, cannot be adjusted. Also, parameters that are limited by hardware and/or software constraints such as Damping cannot be adjusted.

To activate the **Editable Parameters** menu, follow these steps:

1. Press the **[OPTION]** key.
2. Use the slewing keys to select the **Editable Parameters** option.

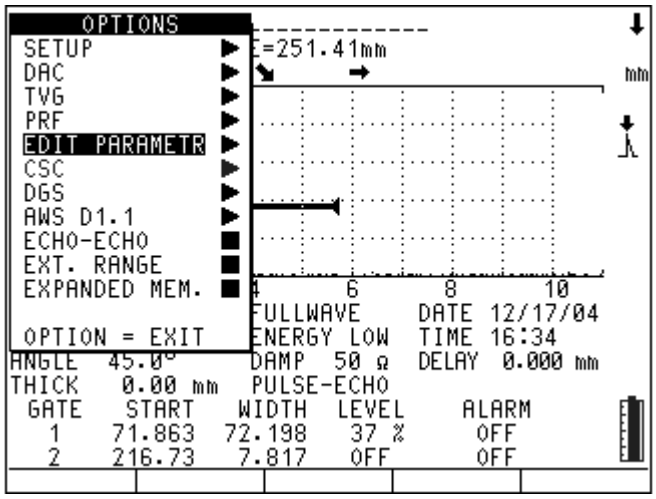


Figure 3 Selecting the Editable Parameters Option

3. Press **[ENTER]**. The *Editable Parameters* screen opens:

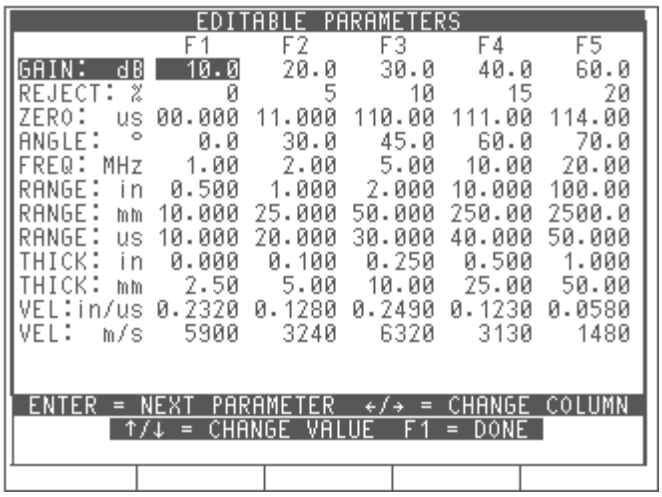


Figure 4 Viewing the Editable Parameters Screen

4. Press the **[ENTER]** key to move downward to different Parameters.
5. Use the left and right slewing keys to select which **[F1]** - **[F5]** parameter to edit.

   Edit each parameter using the up and down slewing keys.

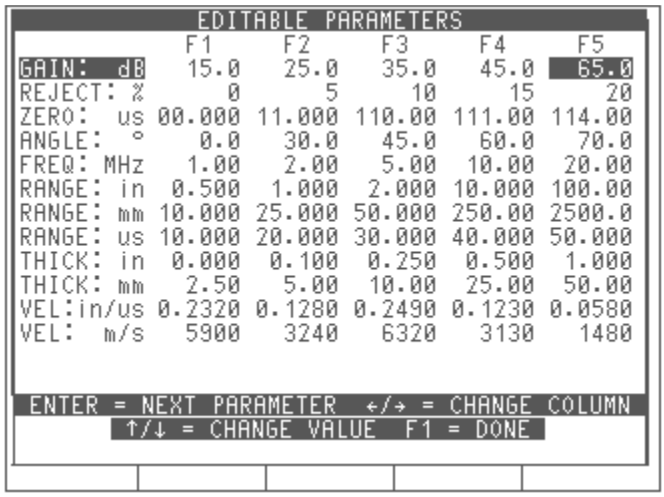


Figure 5 Editing the Gain Parameter

6. Press the **[F1]** key when you have finished editing the parameters to save the settings and return to the **Options** menu.

   When you select one of the parameters that you edited, the new preset values appear above the **[F]** keys.

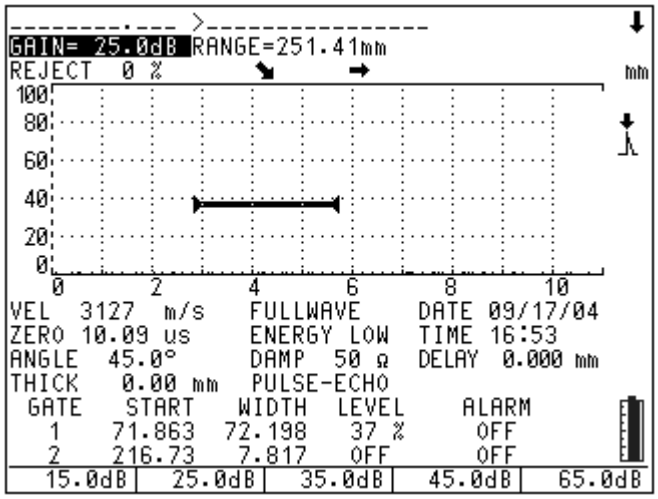


Figure 6 Viewing New Preset Values

3.5 Managing the Display

The EPOCH LT can present the A-Scan in two different display formats – split screen and full screen. A split screen presents simultaneous viewing of the waveform and all instrument set-up data. The full screen presents a large, high resolution waveform and important basic information.

Note: After the EPOCH LT is powered up and completes the self test routine, the split screen opens.

To set the display parameter, press **[DISPLAY]** to switch to full screen or press **[DISPLAY]** again to switch back to the split screen.

3.5.1 Full Screen A-Scan Display

The full screen A-Scan presents a large, high resolution waveform and some basic data to aid with interpretation of the display.

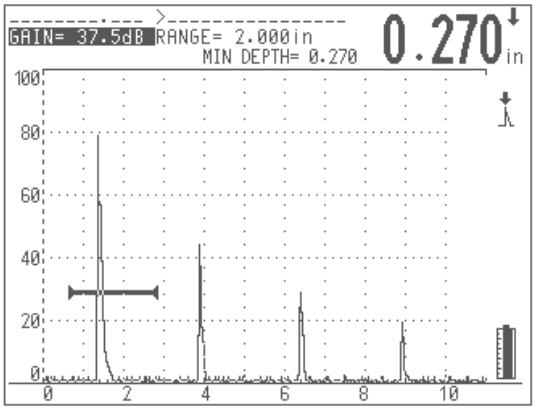


Figure 7 Full Screen Display

Top of the screen

- The Filename, Gain level, ID Code, Range setting, and currently selected parameter are constantly displayed.
- A numeric display shows thickness, soundpath, amplitude, or time-of-flight data pertaining to a gated signal. Use **[DEPTH /%AMPL]** to select which information to show.

Middle of the screen

- Displays the waveform.
- In the background, a numbered graticule shows signal amplitude on the vertical axis and screen division number or the function presets on the horizontal axis. To view the screen divisions instead of the function presets, press **[2nd F],** then **[ZERO OFFSET]** (#DIV).
- On the right side of the waveform display, a set of display flags and markers appear when certain functions are active (See Display Flags and Markers on page 31).

Bottom of the screen

- Displays the preset values for many of the parameters. These are accessed via the function keys.
- The battery level icon is constantly displayed in the bottom right corner.

3.5.2 Split Screen Display

The split screen display presents a condensed waveform and a status display that shows all instrument set-up data. This screen is useful when establishing the initial instrument settings as it enables you to quickly check all set-up information and make adjustments while viewing the waveform display. Even in the split screen mode, the A-scan still has enough resolution to produce accurate waveforms.

To display a split screen, follow these steps:

1. Press **[DISPLAY]** to toggle the display to the split screen.

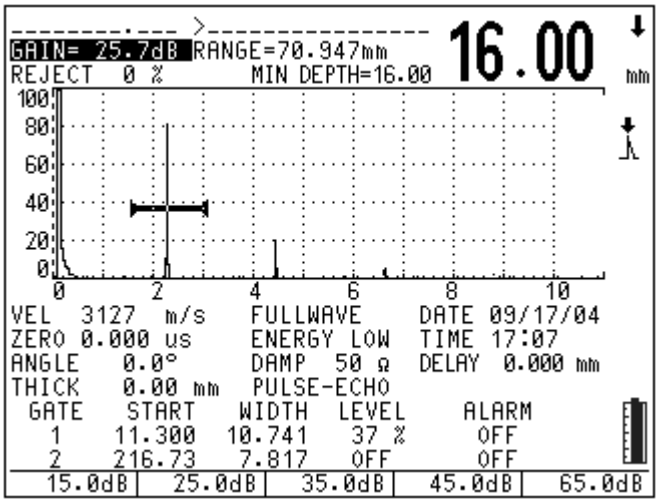
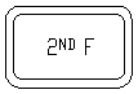


Figure 8 Split Screen Display

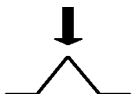
2. Press **[ENTER]** several times to toggle through the instrument parameters.
3. Use the **[↑], [↓], [←],** and **[→]** keys to change the setting from the current highlighted function.

3.5.3 Display Flags and Markers

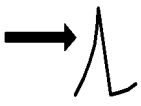
To indicate when particular display functions are active, a set of flags and markers appear on the right side of the waveform display.



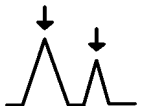
Indicates the **[2nd F]** key has been pressed. The unit is waiting for you to press one of the second function keys. Press **[2nd F]** again to cancel.



Indicates the EPOCH LT is in the **Peak Depth** mode; thickness and soundpath measurements are made to the peak of the highest amplitude signal within the flaw gate. This symbol also appears when the amplitude display is active as all amplitude measurements are made to the peak of the signal.



Indicates the EPOCH LT is in the **Edge Depth** mode and all thickness and soundpath measurements are to the leading edge of the first signal within the flaw gate.



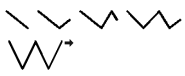
Indicates the EPOCH LT is in the optional **Echo-to-Echo Peak Measurement** mode and the measurement is being made between the peaks of the two selected signals.

Indicates the EPOCH LT is in the optional **Echo-to-Echo Edge Measurement** mode and the measurement is being made between the leading edges of the two selected signals.

P	Indicates the **Peak Memory** function is active.
F	Indicates the display is frozen because the **Freeze** function is active.
Z	Indicates the **Zoom** function is active to expand the region within the flaw gate to full screen width.
A	Indicates the gate alarm is tripped.
TVG	Indicates Time Varied Gain is active.
DAC	Indicates Distance Amplitude Correction is active.
PRF	Indicates **Low PRF (Pulse Repetition Frequency)** is active.
AWS	Indicates **AWS** (American Welding Society Structural Welding Code) software option is active.
CSC	Indicates **CSC** (Curved Surface Correction) option is active.
DGS	Indicates **DGS** (Distance Gain Sizing) option is active.
CAL	Indicates **Calibration** is active.

Indicates the **All Lock** function is active, meaning all keys are locked except [**DISPLAY**], [**OPTION**], [**ENTER**], **[↑], [↓], [←], [→]**, and [**ON/OFF**].

Indicates the **Cal Lock** function is active, meaning you **cannot** use the following keys: [**GAIN**], [**VEL/REJECT**], **[CAL]**, [**ANGLE/ THICKNESS**], [**ZERO OFFSET**], [**PULSER/FILTER**], and [**RANGE**].



Indicates the soundpath leg in which a particular reflector is located – 1st, 2nd, 3rd, 4th, and beyond 4th.

Indicates the remaining battery life in the unit. The battery level is constantly displayed in the lower right corner of the display.

3.6 Setting-up Parameters

The EPOCH LT **Setup** screen allows you to select basic system parameters. To access the **Setup** screen, press [**OPTION]**. Move the highlight bar over **Setup** and press **[ENTER]**. The following screen appears:

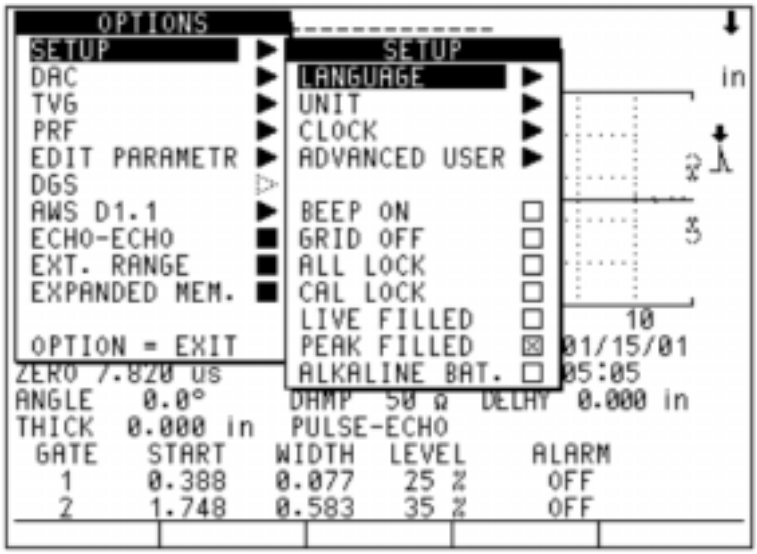


Figure 9 Menu Options

The selections in the **Setup** menu are grouped according to function. Use the green slewing keys to move around this menu. Press [**ENTER**] to select/deselect an item. Press [**OPTION**] to return to the live screen after making choices.

Symbol	Description
▶	When this symbol appears after a menu item, it means that another menu is available. Highlight the item using the slewing keys and press [**ENTER**] to view the next menu.
☐	When this symbol appears after a menu item, it means that multiple items within the group can be selected.
☒	When this symbol appears after a menu item, it means that the item is selected.

Table 4 Menu Symbol Descriptions

3.6.1 Language Selection

You can use the EPOCH LT in any of the following languages:

- English
- French
- German
- Japanese
- Spanish
- Italian
- Russian

Note: The **Custom** option is not active.

To select or change a language to use on the EPOCH LT, follow these steps.

1. Move the highlight bar over the **Language** option and press [**ENTER**].
2. Move the highlighted bar over the desired choice and press **[ENTER]**.
3. Press **[OPTION]** to exit.

3.6.2 Units of Measurement

The EPOCH LT is capable of displaying and calculating distance parameters and soundpath data in terms of distance (inches or millimeters) or time (microseconds). When displaying in terms of distance, the screen can be set to be viewed either in units per division (for example, 1.000 in/div or 25.00 mm/div) or units full scale (for example, 10.00 in full scale or 250 mm full scale). Units full scale describes the distance over the entire screen range.

When displaying in terms of time, all distance parameters (range, zero offset, gate position, material thickness, minimum depth, and all soundpath data) are displayed using microseconds (µs) instead of inches or millimeters.

To change the units of measure, follow these steps:

1. Move the highlight bar over **Unit** and press **[ENTER]**.
2. Use the slewing keys to select the desired unit setting and press **[ENTER]**.
3. Press **[OPTION]** to exit.

3.6.3 Beep On

Note: When **Beep On** is selected, pressing the keypad results in audible beeps.

3.6.4 Grid On/Off

When you select **Grid Off**, only the borders of the graticule shows behind the waveform display. This is a real-time condition only and is not stored.

3.6.5 Keypad Lock Functions

All Lock: When you select **All Lock**, all keys except [**DISPLAY**], [**OPTION**], [**ENTER**], **[↑], [↓], [←], [→]**, and [**ON/OFF**] are inactive.

A full padlock appears above the battery symbol indicator to show that **All Lock** is selected.

Cal Lock: When you select **Cal Lock**, a half padlock appears above the battery indicator and the following keys are inactive:

[**GAIN**]	[**VEL/REJECT**]
[CAL]	[**ANGLE/THICKNESS**]
[**ZERO OFFSET**]	[**PULSER/FILTER**]
[**RANGE**]	

To unlock either the **All Lock** or **Cal Lock**, return to the **Setup** screen and deselect the item.

3.6.6 Filled Live

When you select **Filled Live**, the live waveform appears filled-in, rather than as an outline trace. This is used to make the waveform more visible when viewing in bright sunlight.

3.6.7 Filled Peak

When you select **Filled Peak**, a waveform or echo envelope that is frozen on the screen when using the **Peak Memory** feature appears filled-in, rather than as an outline trace.

4 Adjusting the Pulser Receiver

This chapter describes how to adjust the pulser receiver.

Topics are as follows:

- Adjusting System Sensitivity
- Using AUTO-80%
- Setting Gain Reference Level and Adding Scanning Gain
- Using the Pulser Key

4.1 Adjusting System Sensitivity

To adjust the instrument sensitivity, follow these steps:

1. Press **[GAIN]**.
2. Use the function keys to select preset values for course adjustment.
3. Move the gain upward or downward with the **[↑]** and **[↓]** keys for fine adjustments.

   The current system sensitivity is displayed and highlighted in the upper left corner.
4. Adjust gain in 0.1dB increments by pressing the **[↑]** or **[↓]** key once.
5. Hold the **[↑]** or **[↓]** key to gradually increasing slewing rate.

   Total system sensitivity is 100.0 dB.

4.2 Using AUTO-80%

AUTO-80% is an excellent tool to quickly adjust the gain (dB) setting, bringing the peak of a reference echo to 80% full screen height. AUTO-80% is especially useful in combination with welding applications and codes that require quick gain adjustments to bring an echo to 80% screen height.

You can use AUTO-80% to bring an echo to 80% full screen height in either Gate 1 or Gate 2.

To use Auto-80% with Gate 1, follow these steps:

1. Press **[GATE 1]**.
2. Use the green slewing keys to position the gate over the desired echo. Be sure the echo breaks the gate threshold.
3. Press **[F5]**. The peak of the highest amplitude echo breaking the Gate 1 threshold is brought to 80% screen height.

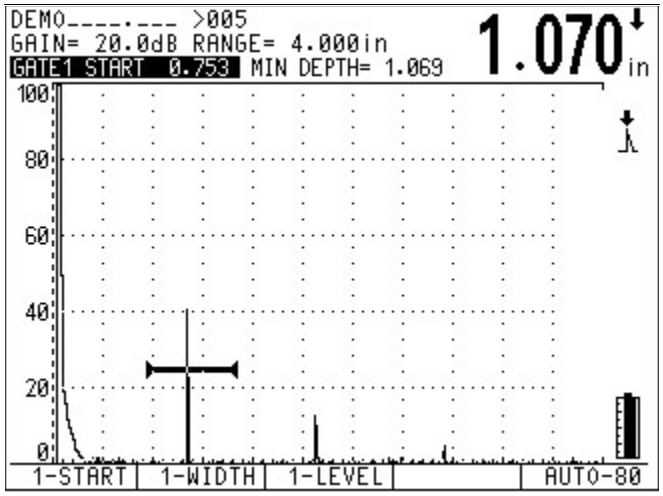


Figure 10 Before Activating AUTO-80%

To use Auto-80% with Gate 2, follow these steps:

1. Press **[GATE 2]**.
2. Press **[F4]** to turn on the gate if necessary.
3. Use the green slewing keys to position the gate over the desired echo. Be sure the echo breaks the gate threshold.
4. Press **[F5]**. The peak of the highest amplitude echo breaking the Gate 1 threshold is brought to 80% screen height.

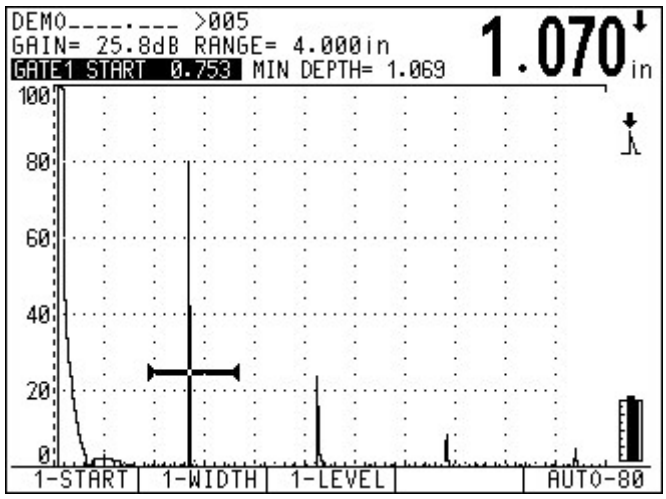


Figure 11 After Activating AUTO-80%

Note: You can use AUTO-80% when an echo exceeds the desired gate threshold. The echo can be either above or below 80% full screen height. If a signal is above 80% screen height, the EPOCH LT reduces gain in a series of repetitions until the signal peaks at 80%. Occasionally, for very high amplitudes (above 500% full screen height), you may need to press the **[F5]** key a second time.

4.3 Setting a Gain Reference Level and Adding Scanning Gain

To establish the current system gain as the reference (base) level, press **[2nd F], [GAIN] (REF)**. This is useful for inspections that require you to establish a reference gain level, then add or subtract additional scanning gain.

After accessing the reference function, the gain display will read: REF XX.X dB + 0.0. You can now add scanning gain independent of the reference gain level.

To add scanning gain, follow these steps:

1. Press **[F2]** to add or subtract scanning gain in 6 dB increments. The cursor position is to the left of the decimal point.
2. Use the **[↑]** and **[↓]** keys to increment or decrement.
3. Press **[F1]** to make adjustments in 0.1dB increments. The cursor position is to the right of the decimal point.
4. Use the **[↑]** and **[↓]** keys to increment or decrement.
5. Use the **[↑]** and **[↓]** keys to increment and decrement the scanning gain.

Tip: Press **[GAIN]** multiple times as another method to toggle back and forth between the 6 dB and 0.1 dB increments.

You can add the scanning gain to the reference level, toggle between the active scanning gain and 0 dB (this is the scan dB feature), or turn it off by pressing the following keys:

[F3]: Adds the reference gain and scanning gain together, and exits the Reference Level function.

[F4]: Scan dB-Toggles the scanning gain back and forth from the active scanning gain and 0 dB.

[F5]: Exits the Reference Level function without adding the entered scanning gain.

Prompts are displayed in the function boxes at the bottom of the screen. If another parameter is accessed, these choices may change, but can be brought up again by pressing **[2nd F]**, **[GAIN] (REF)**.

4.4 Using the Pulser Key

The following pulser receiver and filter parameters can be adjusted on the EPOCH LT keypad:

- Waveform Rectification
- Pulser Energy
- Pulser Damping
- Pulser Test Mode

To access the available parameters, follow these steps:

1. Press **[PULSER]** multiple times to toggle through the several features.
2. Each pulser receiver and filter characteristic adjustments can be done in either full A-Scan or Split Screen.
    - In the full A-scan, the current parameter being adjusted appears at the top left of the screen, directly above the waveform.
    - In the **Split Screen** mode, the parameter is highlighted on the lower half of the EPOCH LT screen.

Note: For reviewing the adjustments in this manual, we use the **Split Screen** mode.

To view how the selections of the pulser receiver affect a waveform, couple a transducer to a sample or test block, which produces an echo on the top half of the screen.

4.4.1 Waveform Rectification

The EPOCH LT can operate in one of four rectification modes:

- Full Wave
- Half Wave Positive
- Half Wave Negative
- RF (unrectified)

The **RF** mode is not active while operating in **DAC** or **TVG** mode, **Peak Memory**, or **Echo-to-Echo** mode.

To select a waveform rectification mode, follow these steps:

1. Press **[PULSER]** once to display the current screen rectification. This is highlighted and displayed at the bottom of the screen.
2. Use the function keys for direct access or the **[▲]** and **[▼]** keys to toggle through the different waveform rectification modes.

4.4.2 Pulser Energy

The EPOCH LT has four pulser energy settings depending upon test conditions:

- Low (100 v) +/- 20%
- Medium (200 v) +/- 20%
- High (300 v) +/- 20%
- Max (400 v) +/- 20%

Tip: Generally, the lower pulser energy settings are used for thin materials, while the higher settings are used for thicker materials and/or highly attenuating materials.

To select a pulser setting, follow these steps:

1. Press **[PULSER]** to access the energy level settings.

   In the **Split Screen** mode, the pulser energy level is highlighted on the lower half of the screen.

2. Use the function keys for direct access or the **[↑]** and **[↓]** keys to move among the four selections.

4.4.3 Damping

The damping control lets you optimize the waveform shape for high resolution measurements via an internal resistive circuit. There are four damping settings:

- 50 ohms
- 63 ohms
- 150 ohms
- 400 ohms

Tip: Generally, the lowest ohm setting increases the system damping and improves near surface resolution, while the highest ohm setting decreases system damping and improves the instrument penetration power.

Selecting the correct damping setting fine tunes the EPOCH LT to operate with a particular transducer selection. Depending on the transducer being used, the various damping settings either improve near surface resolution or alter the instrument's penetration power.

To select a damping option, follow these steps:

1. Press **[PULSER]** to access the Damping parameter.
2. Use the function keys for direct access or the **[↑]** and **[↓]** keys to toggle through the four available damping selections.

4.4.4 Test Mode

The EPOCH LT can operate in three different Test modes:

Pulse-Echo Mode: Single element transducers. Use either connector.

Through Mode: Two separate transducers, typically on opposite sides of the test specimen. Use the top (red) connector as the transmitter.

Dual Mode (Pitch and Catch): One connector acts as a transmitter, while the other acts as a receiver. The top (red) connector is designated as the transmitter.

To select a **Test** mode, follow these steps:

1. Press **[PULSER]** to access the **Test** mode parameter.
2. Use the function keys for direct access or the **[↑]** and **[↓]** keys to toggle through the three selections.

Note: To compensate for the one-way soundpath in **Through** mode, the EPOCH LT does not divide transit time by two when calculating thickness measurements.

5 Managing Special Waveform Functions

This chapter describes how to manage special waveform functions.

Topics are as follows:

- Reject
- Peak Memory
- Screen Freeze

5.1 Reject

The **Reject** function eliminates unwanted, low-level signals from the EPOCH LT's display. Because the EPOCH LT features a digital waveform display, the reject function is linear. **Increasing the reject level does not affect the amplitude of the signals above the reject level.** The reject level is continuously adjustable from 0% to 80% of full scale with 1% resolution and is displayed in the upper left corner of the screen in the split screen view.

Note: It is not possible to add Reject while in the unrectified, RF display.

To access the Reject function, follow these steps:

1. Press **[2ndF]**, **[VEL] (REJECT)**.
2. Use the function keys to select preset values or use the **[↑], [↓], [←],** and **[→]** keys to adjust the reject level upward or downward.

   Any signal whose amplitude is less than or equal to the specified reject level is eliminated from the display.

5.2 Peak Memory

The **Peak Memory** function enables the display to capture and store on the screen the amplitude of each display point. The display updates each pixel if a signal of greater amplitude is acquired. When a transducer is scanned over a reflector, the signal envelope or echo dynamic as a function of transducer position is held on the screen. In addition, the current, live waveform is displayed at the appropriate place within the echo envelope.

This function is useful when it is necessary to peak up an indication during an angle beam calibration.

Note: The **Peak Memory** function cannot be activated in the unrectified, RF display mode.

To activate **Peak Memory**, follow these steps:

1. Press **[PEAK MEM]**.

   A **"P"** appears at the right side of the display to indicate the function is active.

2. Scan over the reflector to acquire the echo envelope. Continue to scan slowly until the live waveform peak matches the peak amplitude of the echo envelope. When these two points match, the signal will be peaked up.

3. Press **[PEAK MEM]** again to shut off **Peak Memory**.

Note: The EPOCH LT software allows you to select whether to view the live waveform and/or the **Peak Memory** echo envelope as an outline or a filled-in trace.

5.3 Screen Freeze

The **Screen Freeze** function holds or freezes the information on the screen at the moment **[FREEZE]** is pressed. Once the **Freeze** function is activated, the pulser receiver of the EPOCH LT becomes inactive and does not acquire any further data. An "**F"** appears to the right of the A-Scan display indicating the function is active.

The **Freeze** function is useful when storing waveforms as it holds the current A-Scan allowing the transducer to be uncoupled from the test material. Once the display is frozen, you can do a variety of functions such as storage of the waveform or thickness data and entry of an alphanumeric location code or memo to describe the data. It is possible to manipulate the gates to obtain thickness or soundpath data.

The **Freeze** function differs from **Peak Memory** in that no new data is acquired and added to the instrument display. The **[FREEZE]** key is ideal for high temperature measurements.

When **Freeze** is active, the following parameters cannot be changed/accessed:

- Zero Offset
- Range
- Zoom
- Reject
- Gain
- Reference Gain
- Peak Memory
- Pulser Receiver

To disable the **Freeze** function and return to normal operation, press **[FREEZE]** again.

6 Using the Gates

This chapter describes how to use the EPOCH LT gates.

Topics are as follows:

- Positioning Gate 1
- Positioning Gate 2
- Making Thickness Readings
- Using the Echo-to-Echo Software Option
- Locating Flaws with an Angle Beam Transducer
- Measuring Signal Amplitude
- Operating Time-of-Flight Mode
- Using the Zoom Feature
- Activating Gate Alarms

6.1 Positioning Gate 1

Gate 1 is the primary flaw gate. It provides thickness readings in both the A-Scan and unrectified RF displays, soundpath data when using an angle beam transducer, signal amplitude, time of flight data, or minimum depth or threshold alarm triggers.

Movement of Gate 1 is controlled via the red **[GATE 1]** key.

To access the starting position, width, or level of Gate 1, follow these steps:

1. Press **[GATE 1]**.
2. Press the appropriate function key.

Tip: You can also access the start, width, and level by pressing **[GATE 1]** multiple times. Use the **[↑], [↓], [←],** and **[→]** keys to position the gate.

6.2 Positioning Gate 2

Gate 2 is a secondary gate used when making echo-to-echo thickness readings or when multiple alarm gates are required. To access Gate 2, follow these steps:

1. Press **[GATE 2]** to view Gate 2 controls.
2. Press **[F4]** for ON. The movement of Gate 2 is done in the same manner as Gate 1.
3. Press **[GATE 1]** to switch back to control Gate 1.
4. To turn Gate 2 off, press **[GATE 2]** followed by **[F4]**.

6.3 Making Thickness Readings

The EPOCH LT is equipped with a high resolution distance calculator that provides a direct readout of thickness, soundpath, or time-of-flight data across the top of the A-Scan. Depth measurements can be made in two different ways. Some applications may require measuring to the leading edge of the signal, while others may require measuring to the peak of the signal.

To take a thickness reading, assuming that the EPOCH LT is properly calibrated (See Calibrating the EPOCH LT on page 55), follow these steps:

1. Position Gate 1. Because Gate 1 is used to obtain single echo thickness readings, it must be positioned correctly. To obtain a thickness reading, the appropriate echo on the display must exceed the gate threshold. Make sure that Gate 1 starts at less than the minimum expected thickness value and that its width exceeds the maximum expected value.

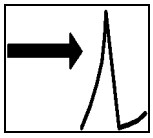
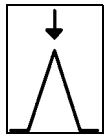
Note: When the gage is used for thickness gaging, set Gate 1 level just high enough to avoid false readings. When the gage is used for flaw detection, set Gate 1 according to appropriate acceptance and rejection criteria.

2. Select the **Measurement** mode. The EPOCH LT can measure to either the leading edge or the peak of a signal.
3. Press **[DEPTH/%AMPL]**to select the appropriate mode. The following selections will appear in the function boxes below the A-Scan display:

   F1 = EDGE F2 = PEAK F3 =%AMP F4 = TOGGLE

   The F4 = TOGGLE selection only appears when the unit has a refracted angle entered and when either the peak or edge mode is selected.
4. Press **[F4]** multiple times to allow you to select which of the soundpath readings (depth, surface distance, or total soundpath) is displayed in large bold text.
5. Select **[F1]** or **[F2]** to put the EPOCH LT in the corresponding **Depth Measurement** mode.
6. Select **[F3]** to put the EPOCH LT into the **Amplitude Measurement** mode.

   One of the following icons appears next to the upper right corner of the A-Scan.


Edge Depth

Peak Depth

   While in **Edge Depth** mode, thickness readings are made to the leading edge of the first signal to exceed the flaw gate level. In **Peak Depth** mode, thickness readings are made to the peak of the highest amplitude signal that falls within the gate.

If no refracted angle is entered, a Minimum Depth value appears above the display. This value refers to the minimum detected thickness value and is only updated if a lower value is measured. To reset the minimum depth value, press either **[GATE 1]** or **[GATE 2]**.

Note: To obtain the most accurate and consistent thickness or soundpath readings, select the **Peak Depth** mode. The apparent arrival time of the leading edge of a signal varies with the signal amplitude. As a result, the instrument gain setting, coupling conditions, and any other factor affecting signal amplitude has an impact on the accuracy of a reading made in the Edge Depth mode. The effects of these factors are not completely eliminated in the Peak Depth mode, but they are greatly reduced. If **Peak Depth** is selected, perform calibrations using the peak of the signal. However, when using a dual transducer, due to the jagged peaks, we recommend you use **Edge Depth**.

6.4 Using the Echo-to-Echo Software Option

Using this Echo-to-Echo software option, you can make measurements between successive echoes. Measurements can be made between two consecutive backwall echoes or between an interface echo and any other selected signal, in which you can measure thickness through coatings or perform low speed immersion testing.

6.5 Locating Flaws with an Angle Beam Transducer

During an angle beam inspection, you can obtain accurate and reliable soundpath information using the EPOCH LT's high resolution distance calculator.If a refracted angle is entered into the EPOCH LT and an echo is exceeding the gate threshold, all angular soundpath components are displayed at the top of the A-Scan display.

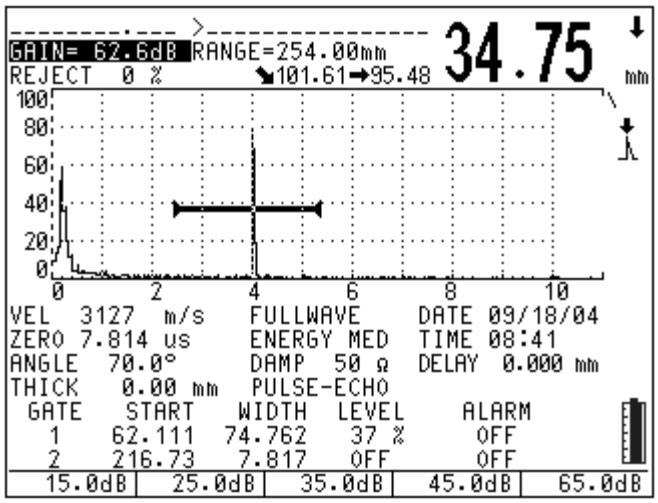


Figure 12 Angle Beam Inspection

These symbols represent the following distances:

= angular (soundpath) distance to the reflector

= urface distance (projection) to the reflector

= depth to the reflector

= soundpath leg in which the particular reflector is located – 1st, 2nd, 3rd, 4th, beyond 4th

The selection of the **Measurement** modes (**Peak Depth** or **Edge Depth**) and the ability to toggle the soundpath reading are shown above. See Making Thickness Readings on page 46.

Any signal breaking the gate threshold generates the display of soundpath data.

To setup information in the first leg of the soundpath, follow these steps:

1. Enter a value of 0 for material thickness into the EPOCH LT when calibrating.
2. Press **[2nd F], [ANGLE] (THICKNESS)**.
3. Press **[F1]** or use **[↓]** until the thickness value reads 0.00. With this set-up, all soundpath data is treated as if the information is in the first leg.

When working beyond the first leg, it is imperative that you enter an exact thickness of the material into the EPOCH LT. Press **[2nd F], [ANGLE] (THICKNESS)** and use **[↑], [↓], [←],** and **[→]** to enter the proper thickness. You can also use the function keys to quickly select preset values. This value is then used to calculate the depth to a reflector that lies beyond the first leg.

6.6 Measuring Signal Amplitude

When estimating discontinuity size, the instrument is adjusted so that a particular gain setting and screen height represent the echo amplitude produced by a known size reflector in a reference standard. In general, a signal with smaller amplitude may indicate a smaller reflector and a signal with higher amplitude may indicate a larger reflector than the reference standard.

Press **[DEPTH/%AMPL]** and then **[F3]** to display a direct on-screen readout of amplitude information.

If an echo exceeds the gate threshold and the EPOCH LT is in the **Amplitude** mode, the amplitude information for that echo is displayed as a percentage of full screen height as both **Current Amp** and **Amp Max**.

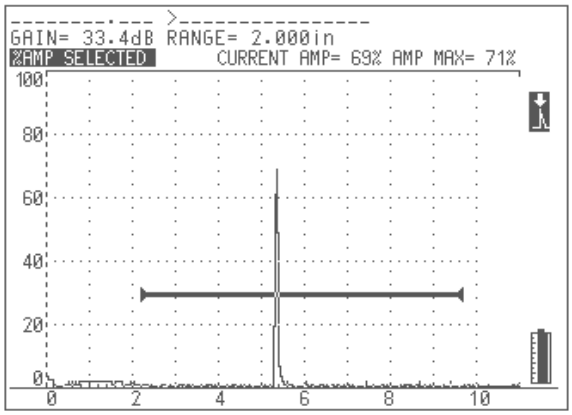


Figure 13 Amplitude Mode Displaying **Current Amp** and **Amp Max**

Current refers to the real time percentage of screen height of the highest amplitude signal within the gate.

The **Amplitude Max** display retains the highest amplitude of a signal that has broken the gate threshold. If a higher amplitude signal is read, the **Amplitude Max** value is updated. Reset the maximum amplitude value by pressing any one of the red gate keys.

If there is no echo within the gate, **Current** will read "_____%" indicating no reading was taken.

6.7 Operating Time-of-Flight (TOF) Mode

The EPOCH LT is capable of displaying Time-of-Flight (TOF) soundpath data for an echo that breaks the gate. Time-of-Flight is the location of the reflector in terms of microseconds (µs).

When the **Time-of-Flight** mode is turned on, all EPOCH LT distance parameters are displayed using µs values instead of inches or millimeter values.

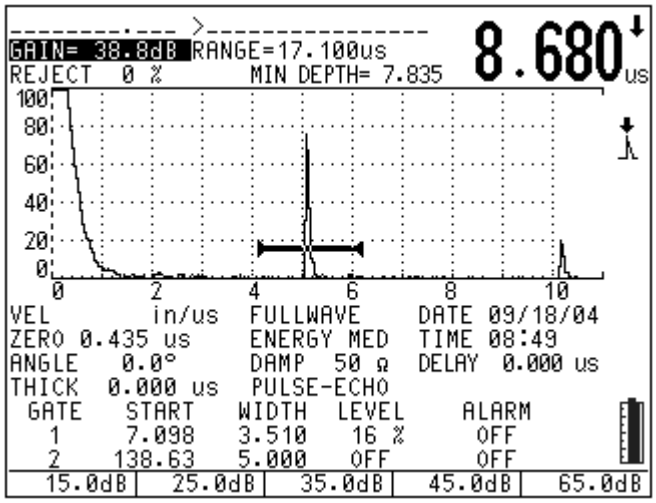


Figure 14 **Time-of-Flight** Mode Displaying µs Values

To setup the **Time-of-Flight** mode, follow these steps:

1. Use the **Setup** menu to turn on **Time-of-Flight** mode.
2. Press [**OPTION**].
3. Move the highlight bar over **Setup** and press [**ENTER**].
4. Move the highlight bar over **Unit** and press **[ENTER]**.
5. Move the highlight bar over µs **Full Scale** to viewin units full scale, or µs /DIVISION to view in units per division and press [**ENTER**].
6. Press [**OPTION**] to return to the live screen.

6.8 Using the Zoom Feature

To zoom in on an indication, position Gate 1 over the area of interest and press **[2nd F]**, **[RANGE] (ZOOM)**. The instrument automatically uses material delay to bring the point that corresponds to the gate start to the screen's left side and also adjusts the displayed range to match the gate width. The new range equals the unzoomed gate width. The lowest achievable value of the expanded range is equivalent to the minimum range of the instrument at the current material velocity setting.

Flaw Detection

Zoom is useful in certain flaw detection applications, for example, in the detection of faceted defects such as inter-granular stress corrosion cracking (IGSCC). The inspector's job can be complicated by the geometry of the test specimen and also by the specific characteristics of the defect itself. In instances where the pipe counterbore is close to the weld root, it is possible to have three signals that all appear quite close to each other, from the weld root, the counterbore, and the crack itself. Use the **Zoom** function to improve the

visual resolution of the EPOCH LT display so that each individual signal can be more easily identified.

When evaluating a crack signal, the inspector's attention is usually focused on the leading edge of an indication. By observing the number and location of small peaks along the leading edge of the signal, it is possible to make some assumptions regarding the presence and location of different facets of the crack. Use the **Zoom** function to get a much more detailed view of an indication and thus make better judgements regarding flaw location and depth.

Zoom is useful when inspecting particularly large or thick components when detail is lost due to using long screen ranges. Use the **Zoom** function to look at small sections of the test piece without disturbing the instrument's original calibration.

6.9 Activating Gate Alarms

The EPOCH LT features a variety of alarm configurations that can be used in either the **Single** or **Dual Gate** modes. An alarm on Gate 2 can only be set if Gate 2 is turned on by pressing **[GATE 2]** and then pressing **[F4]** for ON.

6.9.1 Threshold Alarms

Threshold alarms can be set on Gate 1 and/or Gate 2.

To set a threshold alarm on Gate 1, follow these steps:

1. Press **[GATE 1]** and use the start, width, and level parameters to position the gate over the desired area.
2. Press **[2nd F], [GATE 1] (ALARM 1)**. The alarm choices are displayed in the function boxes at the bottom of the screen.
3. Press **[F1]** for positive logic or **[F2]** for negative logic. A negative logic alarm indicates a signal is absent from the gate. A positive logic alarm indicates a signal is present within the gate. Either Gate 1 or Gate 2 can be set positive or negative.

   Once a threshold alarm is activated, markers at the starting and ending points of the gate will point upwards or downwards to indicate which type of alarm has been set.

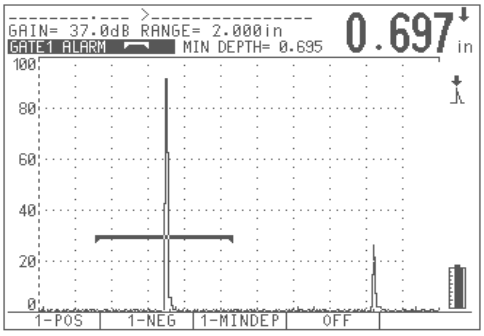


Figure 15 Negative Logic Alarm

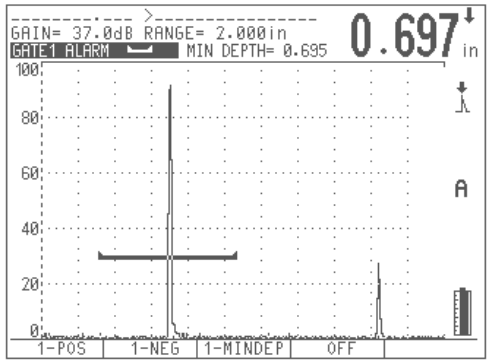


Figure 16 Positive Logic Alarm

4. Press **[2nd F]**, **[GATE 1] (ALARM 1)** and then press **[F4]** for OFF to shut off the Gate 1 alarm.
5. Press **[2nd F]**, **[GATE 2] (ALARM 2)** and then press **[F4]** for OFF to shut off the Gate 2 alarm.

6.9.2 Minimum Depth Alarm

The EPOCH LT is equipped with a minimum depth alarm, which is triggered whenever the current thickness reading falls below an operator defined level. Use the minimum depth alarm with a single gate or in the optional **Echo-to-Echo** measurement mode. In Echo-to-Echo mode, the cursor appears on the second gate. A cursor appears at the bottom of Gate 2 to indicate this level.

6.9.3 Minimum Depth Alarm with a Single Gate

Minimum depth alarms can be set on Gate 1 and/or Gate 2.

To set a minimum depth alarm on Gate 1, follow these steps:

1. Press **[GATE 1]** and use the start, width, and level parameters to position the gate over the desired area. Be sure the gate start position is set to cover a range below the minimum depth alarm value.
2. Press **[2nd F], [GATE 1]** (**ALARM 1**) to display the alarm choices in the function boxes at the bottom of the screen. Press **[F3]** to activate the minimum depth alarm.
3. Use the **[↑], [↓], [←],** and **[→]** keys to set the desired minimum value. The range of minimum depth values is limited by the gate start and width settings.The minimum depth alarm value must be greater than the gate start value and less than the gate width value. Once activated, a marker appears on the gate to indicate the current setting. Any indication that exceeds the gate threshold to the left of the marker will activate the alarm.
4. Press **[2nd F]**, **[GATE 1]** (**ALARM 1**) and then press **[F4]** to shut off the alarm.

6.9.4 Minimum Depth Alarm in the Optional Echo-to-Echo Mode

Use the minimum depth alarm when making Echo-to-Echo thickness readings. In the **Echo-to-Echo** mode, the minimum depth marker appears on Gate 2.

To set the minimum depth alarm when in the **Echo-to-Echo** mode, follow these steps:

1. Position Gate 1 and Gate 2 over the desired areas. (See Using the Echo-to-Echo Software Option on page 47.) Be sure the start position of Gate 2 is set to cover a range below the minimum depth value that will be used for the alarm.
2. Press **[2nd F], [DEPTH/%AMP]** (**ECHO-ECHO**) to activate the **Echo-to-Echo Measurement** mode.
3. Press **[2nd F]**, **[GATE 2]** (**ALARM 2**) to activate the alarm.
4. Press **[F3]** to select the minimum depth alarm.
5. Use the **[↑], [↓], [←],** and **[→]** keys to set the desired minimum value. The range of minimum depth values is limited by the start and width settings of both gates. Gate 1 must be positioned to detect the first back echo. Also, the minimum depth alarm value must be greater than the blank period between Gate 1 and Gate 2 and less than the Gate 2 width value.

6.9.5 Alarm Condition Storage

When an alarm is active, a capital letter **A** flashes to the right of the A-Scan. Alarm conditions can be saved in the EPOCH LT's datalogger. All data with an alarm is flagged in memory by the **@** character before the ID.

7 Calibrating the EPOCH LT

This chapter describes how to calibrate the EPOCH LT. Calibration is the process of adjusting the unit so that it measures accurately on a particular material, using a particular transducer at a particular temperature. You must adjust the **Zero Offset** and **Velocity** parameters of the EPOCH LT during calibration. **Zero Offset** (sometimes referred to as probe delay) compensates for the time between initiating the Main Bang and the entry of the sound into the test piece. The unit must be programmed with the correct **Velocity** setting so that it matches the material velocity of the test piece.

The EPOCH LT has an advanced Auto-Calibration feature, which provides for a fast and easy calibration process. The following sections detail the procedure to calibrate the EPOCH LT when using the four basic transducer configurations: straight beam, delay line, dual element, and angle beam.

Note: Do **NOT** use the Auto-Calibration feature when the EPOCH LT is in the following modes:
- Microsecond Time-Of-Flight
- DAC
- TVG

Topics are as follows:

- Getting Started
- Calibrating with a Straight Beam Transducer
- Calibrating with a Delay Line Transducer
- Calibrating with a Dual Element Transducer
- Calibrating with an Angle Beam Transducer

7.1 Getting Started

Until you are completely comfortable operating the EPOCH LT, we recommend that a basic review and set-up procedure be used prior to starting the actual calibration. The split-screen feature of the EPOCH LT is useful for this as it lets you simultaneously view the waveform display and all instrument calibration data.

To setup the EPOCH LT before calibrating, follow these steps:

1. Press **[DISPLAY]** to select the split screen display.
2. Press **[2nd F]**, **[VEL] (REJECT)** to set the reject level to 0%. Press **[F1]** or use the **[↓]** slewing key to adjust the value to zero.
3. Press **[GAIN]** to select an initial gain value that is appropriate for the calibration and adjust the value by using the direct access function keys or the **[↑]** and **[↓]** keys. If the appropriate gain level is unknown, set the initial gain at 30 dB and adjust it as necessary during calibration.

4. Press **[VEL]** to enter an approximate velocity for the test material and adjust the value with the function keys or the **[↑]** and **[↓]** keys. If the velocity value is unknown, find a starting value in the velocity in Appendix B of this manual.
5. Press **[RANGE]** to set the range and then adjust the value using the function keys or the **[↑], [↓], [←],** or **[→]** keys.
6. Press **[2nd F], [ANGLE] (THICKNESS)** to set the material thickness to 0.00" or 0.00 mm. Press **[F1]** or use the **[↓]** key to adjust the value to zero.
7. Press **[ZERO OFFSET]** to set the zero offset value to 0.00 µsec. Press **[F1]** or use the **[↓]** or **[→]** keys to bring the initial pulse to the left side of the instrument screen.
8. Press **[ANGLE]** to enter the correct refracted angle for the probe (0 for a straight beam or 90^{o} probe, 45 for a 45^{o}, etc.) Use the function keys to access preset values or adjust in 0.1^{o} adjustments using the **[↑]** and **[↓]** keys.

7.2 Calibrating with a Straight Beam Transducer

Use Panametrics-NDT™ transducer part number A109S-RM with a frequency of 5.0 MHz and an element diameter of 0.50" (13 mm) to perform the sample Straight Beam calibration. The calibration requires a test block with two known thicknesses made from the material to be measured. Ideally, the two thicknesses should represent thicknesses that are both below and above the expected thickness of the material being inspected.

For this example, we are using Panametrics-NDT standard 5-step steel test block part number 2214E. The steps measure 0.100", 0.200", 0.300", 0.400", and 0.500".

Note: If the EPOCH LT is set to metric units, the calibration process is exactly the same, except that the entries below will be in millimeters, rather than inches.

To calibrate using a Straight Beam transducer, follow these steps:

1. Follow the initial set-up procedure outlined above. Connect the transducer to an appropriate cable and then connect the cable to either of the transducer posts on the EPOCH LT.
2. Press **[CAL]**. A Cal symbol appears to the right of the A-Scan, signifying the EPOCH LT is in the **Auto-Calibration** mode. To exit the **Auto-Calibration** mode at any point, press [**ENTER**].
3. Couple the transducer to the THIN calibration block step. For this example, the transducer is coupled to the 0.200" step. Depending on the frequency of the contact transducer being used, it may be impossible to obtain a proper reading on a very thin material.
4. Position Gate 1 so that the first backwall echo from the known thickness step exceeds the gate threshold. Adjust the gain setting so that the echo amplitude is approximately 80%.

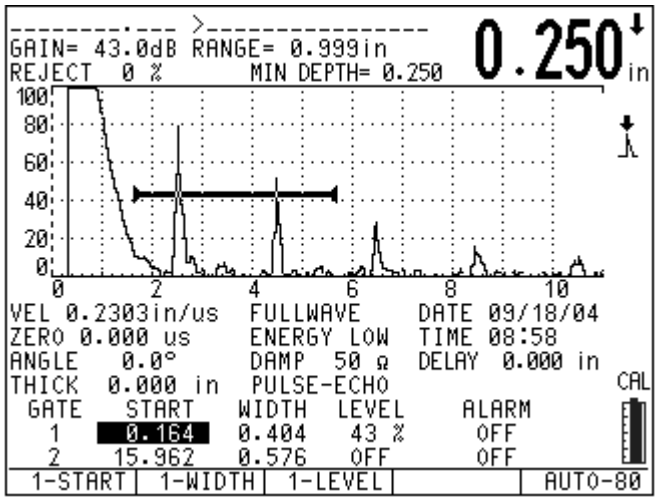


Figure 17 Calibrating for a Thin Block Using a Straight Beam Transducer

5. A thickness reading appears in large text above the A-Scan. Once a steady reading is achieved, press [**ZERO OFFSET**]. The screen freezes and a pop-up box appears on the screen.

   Use the **[▲]** and **[▼]** slewing keys to enter the exact known thickness of the test sample.

Figure 18 Entering a Thin Standard Value

6. Press **[CAL]**. The display returns to the live A-Scan. Couple the transducer to the THICK calibration block step. For this example, the transducer is coupled to the 0.500" step.
7. Position Gate 1 so that the first backwall echo from the known thickness step is exceeding the gate threshold. Adjust the gain setting so that the echo amplitude is approximately 80%.

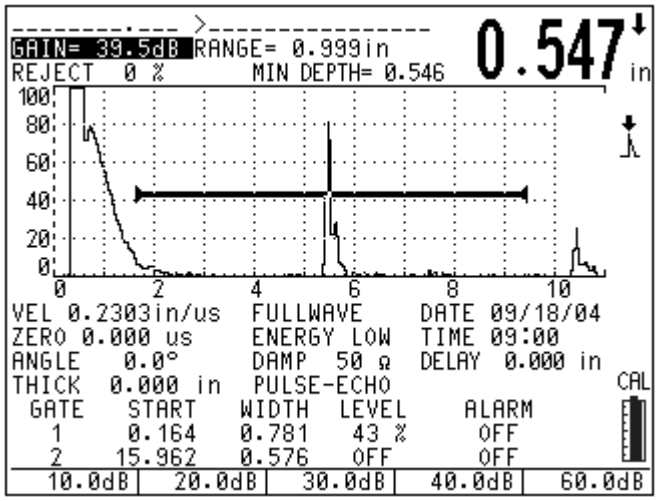


Figure 19 Calibrating for a Thick Block Using a Straight Beam Transducer

8. A thickness reading appears in large text above the A-Scan. Once a steady reading is achieved, press **[VEL**]. The screen freezes and a pop-up box appears again on the screen.

   Use the **[↑]** and **[↓]** slewing keys to enter the exact known thickness of the test sample.

Figure 20 Entering a Thick Standard Value

9. Press [**ENTER**] to complete the Auto-Calibration. The **Zero Offset** and **Velocity** parameters adjust automatically and the correct thickness reading of any gated echo displays on the screen.

Note: It is possible to use the Auto-Calibration feature on a single test block of known thickness. You can use multiple backwall echoes instead of coupling on both a thin step and a thick step. You can leave the transducer coupled on the thin step, move the gate over to one of the multiple backwall echoes and enter the correct soundpath thickness (2, 3, 4, etc. multiple of the first backwall echo) during the velocity portion of the calibration.

7.3 Calibrating with a Delay Line Transducer

The sample delay line calibration described below is performed using Panametrics-NDT™ transducer part number V202-RM, with a frequency of 10.0 MHz and an element diameter of 0.25" (6 mm). The calibration requires a test block with two known thicknesses made from the material to be measured. Ideally, the two thicknesses measurements are both below and above the expected thickness of the material to be inspected.

For this example, we are using a Panametrics-NDT standard 5-step steel test block part number 2211E. The steps measure 0.100", 0.200", 0.300", 0.400", and 0.500".

Note: If the EPOCH LT is set to work in metric units, the calibration process is exactly the same, except that the entries below will be in millimeters, rather than inches.

To calibrate using a Delay Line transducer, follow these steps:

1. Follow the initial set-up procedure outlined in Section 7.1.

   Connect the transducer to an appropriate cable and then connect the cable to either of the transducer posts on the EPOCH LT. With a Zero Offset of 0.000 µs, the Main Bang (or excitation pulse) should appear on the left side of the screen.

   Increase the Zero Offset until the Main Bang moves off the left side of the screen and the interface echo from the end of the delay line tip appears on the screen.

   Verify that the echo represents the end of the delay by tapping your finger on the end of the couplant-coated delay line. This dampens the signal and the echo should jump up and down on the screen. Use the Zero Offset to move this echo to the left side of the screen so that it is barely visible.

2. Press **[CAL]**. A **Cal** symbol will appear to the right of the A-Scan, signifying the EPOCH LT is in the **Auto-Calibration** mode. To exit the **Auto-Calibration** mode at any point, press [**ENTER**].

3. Couple the transducer to the THIN calibration block step. For this example, the transducer will be coupled to the 0.100" step.

4. Position Gate 1 so that the first backwall echo from the known thickness step is exceeding the gate threshold. Adjust the gain setting so that the echo amplitude is approximately 80%. A thickness reading appears in large text above the A-Scan.

Note: Make sure it is the first backwall echo being gated, not a multiple echo from the end of the delay line tip.

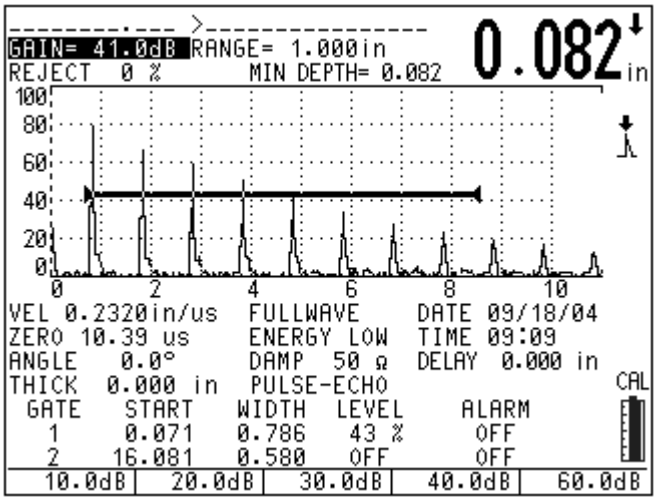


Figure 21 Calibrating for a Thin Block Using a Delay Line Transducer

5. Press **[ZERO OFFSET**] once the reading is steady. The screen freezes and a pop-up box appears on the screen.

   Use the **[↑]** and **[↓]** slewing keys to enter the exact known thickness of the test sample.

Figure 22 Entering a Thin Standard Value

6. Press **[CAL]**. The display returns to the live A-Scan. Couple the transducer to the THICK calibration block step. For this example, the transducer is coupled to the 0.500" step.
7. Position Gate 1 so that the first backwall echo from the known thickness step is exceeding the gate threshold. Adjust the gain setting so that the echo amplitude is approximately 80%. A thickness reading appears in large text above the A-Scan.

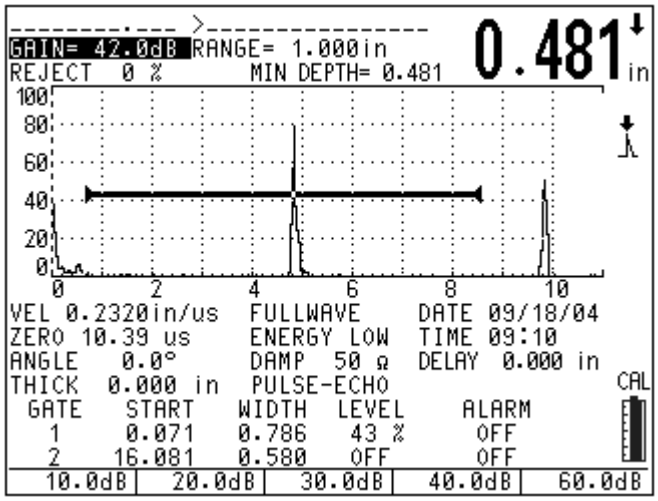


Figure 23 Calibrating for a Thick Block Using a Delay Line Transducer

8. Press [**VEL**] once the reading is steady. The screen freezes and a pop-up box appears again on the screen.

   Use the **[↑]** and **[↓]** slewing keys to enter the exact known thickness of the test sample.

Figure 24 Entering a Thick Standard Value

9. Press [**ENTER**] to complete the Auto-Calibration. The **Zero Offset** and **Velocity** parameters adjust automatically, and the correct thickness reading of any gated echo is displayed on the screen.

Note: It is possible to use **Auto-Calibration** on a single test block of known thickness. You can use "multiple backwall echoes" instead of coupling on both a thin step and a thick step. You can leave the transducer coupled on the thin step, and instead move the gate over to one of the multiple backwall echoes and enter the correct soundpath thickness (2, 3, 4, etc. multiple of the first backwall echo) during the velocity portion of the calibration.

7.4 Calibrating with a Dual Element Transducer

The sample delay line calibration described below is performed using Panametrics-NDT™ transducer part number DHC711-RM, with a frequency of 5.0 MHz and an element diameter of 0.25" (6 mm). The calibration requires a test block with two known thicknesses made from the material to be measured. Ideally, the two thicknesses should represent thicknesses that are both below and above the expected thickness of the material to be inspected.

For this example, we are using a Panametrics-NDT standard 5-step steel test block part number 2214E. It has steps measuring 0.100", 0.200", 0.300", 0.400", and 0.500".

Note: If the EPOCH LT is set to work in metric units, the calibration process is exactly the same, except that the entries below will be in millimeters, rather than inches.

Note: Due to acoustic characteristics of dual transducers, a non-linearity in the distance calibration occurs as the thickness of the material decreases. The point of maximum sensitivity is determined by the “roof angle” of the particular dual transducer. We recommend that the distance calibration is carried out using a step block that covers the range of interest. Be careful interpreting thickness readings made outside the calibrated range. The EPOCH LT does not have V-Path Correction, therefore, there may be some non-linearity within the calibrated range depending on the minimum thickness used in the calibration process.

The zero offset value of dual element transducers can vary significantly at extreme temperatures. If the temperature changes more than a few degrees from the temperature at which the zero offset value was established, re-check its value. If thickness measurements are to be made over a wide temperature range, we strongly recommend the use of Panametrics-NDT dual transducers that are designed for high temperature applications. These have built-in delay lines with a stable sound velocity that does not change significantly with temperature. Specific recommendations are Panametrics-NDT D790-SM and D791 dual element transducers.

To calibrate using a Dual Element transducer, follow these steps:

1. Follow the initial set-up procedure outlined in Section 7.1.

   Connect the transducer to an appropriate cable and then connect the cable to the transducer posts on the EPOCH LT. Change the **Test** mode to **Dual**. Also, when using a dual element transducer, the Gain setting is generally set very high so that the leading edge of the backwall echoes appears as near-vertical lines on the screen. The leading edge is then used when making thickness measurements. For this reason, the EPOCH LT should be set to **Edge Detection** mode.

2. Press **[CAL]**. A Cal symbol appears to the right of the A-Scan, signifying the EPOCH LT is in the **Auto-Calibration** mode. To exit the **Auto-Calibration** mode at any point, press [**ENTER**].

3. Couple the transducer to the THIN calibration block step. For this example, the transducer will be coupled to the 0.100" step. As noted above, a higher Gain setting is required to produce a clean leading edge of the signal. Do not be concerned with the jagged peaks of the echo. Concentrate on the leading edge only.
4. Position Gate 1 so that the leading edge of the backwall echo from the known thickness step is exceeding the gate threshold. A thickness reading appears in large text above the A-Scan.

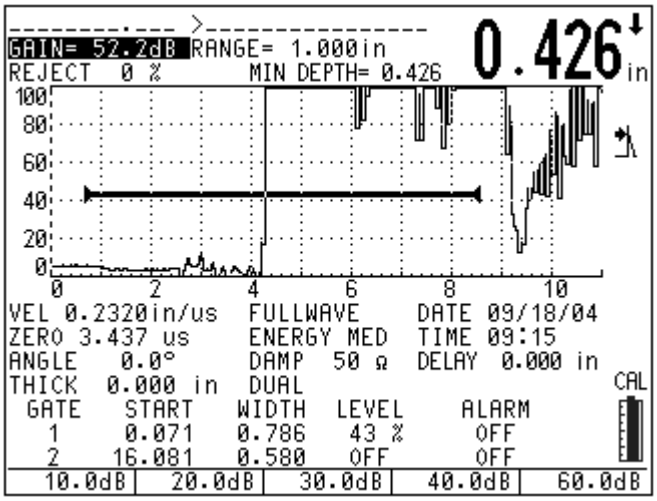


Figure 25 Calibrating for a Thin Block Using a Dual Element Transducer

5. Press [**ZERO OFFSET**] once the reading is steady. The screen freezes and a pop-up box appears on the screen.

   Use the **[▲]** and **[▼]** slewing keys to enter the exact known thickness of the test sample.

Figure 26 Entering a Thin Standard Value

6. Press **[CAL]**. The display returns to the live A-Scan. Couple the transducer to the THICK calibration block step. For this example, the transducer is coupled to the 0.500" step.
7. Position Gate 1 so that the leading edge of the backwall echo from the known thickness step is exceeding the gate threshold. A thickness reading appears in large text above the A-Scan.

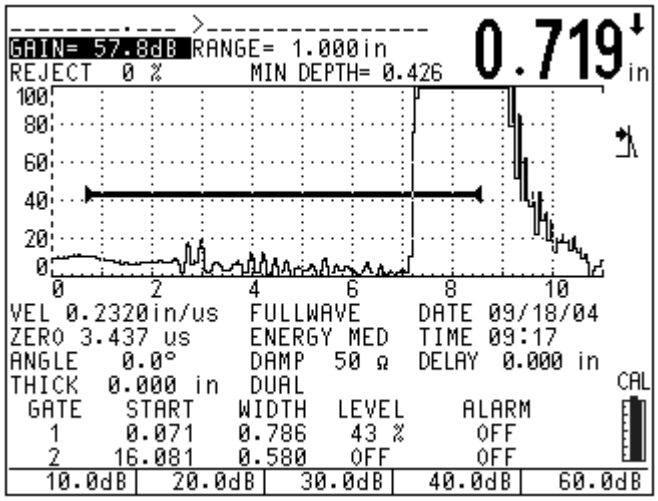


Figure 27 Calibrating for a Thick Block Using a Dual Element Transducer

8. Press [**VEL**] once the reading is steady. The screen freezes and a pop-up box appears again on the screen.

   Use the **[↑]** and **[↓]** slewing keys to enter the exact known thickness of the test sample.

Figure 28 Entering a Thick Standard Value

9. Press [**ENTER**] to complete the **Auto-Calibration**. The **Zero Offset** and **Velocity** parameters adjust automatically, and the correct thickness reading of any gated echo is displayed on the screen.

7.5 Calibrating with an Angle Beam Transducer

The sample angle beam calibration described below is performed using Panametrics-NDT™ transducer part number A420S-SB, with a frequency of 2.25 MHz and an element diameter of 0.625" x 0.625". The transducer is mounted on a 45^{o} wedge, part number ABWS-6-45. We recommend using either an ASTM E-164 IIW Type I or a U.S. Air Force IIW Type II Calibration Block for this procedure. The steps below use a Panametrics-NDT IIW Type I carbon steel calibration block, part number TB7541-1.

To calibrate using an Angle Beam transducer, follow these steps:

1. Follow the initial set-up procedure outlined in Section 7.1.

Connect the transducer to an appropriate cable and then connect the cable to either of the transducer posts on the EPOCH LT.

2. Enter the correct refracted angle for the transducer/wedge combination. For this example, enter 45°.
3. Enter the approximate shear wave velocity of the material being inspected. For this example using carbon steel, enter a velocity of 0.1280 in/µs (3251 mm/µs if working in metric units).
4. Enter an appropriate range for the test block being used. For this example, enter a range of 10.000" (250.00 mm if working in metric units).

See sections 7.5.1 - 7.5.4 for the following procedures:

- Locating the Beam Index Point (B.I.P.) of the probe
- Verifying the Refracted Angle (Beta)
- Calibrating for Distance
- Calibrating for Sensitivity

Note: If the EPOCH LT is set to work in metric units in each procedure listed above, the calibration process is exactly the same, except that the entries below will be in millimeters, rather than inches.

7.5.1 Locating the Beam Index Point (B.I.P.)

To locate the BIP, follow these steps:

1. Couple the probe to the test block at the "0" mark.

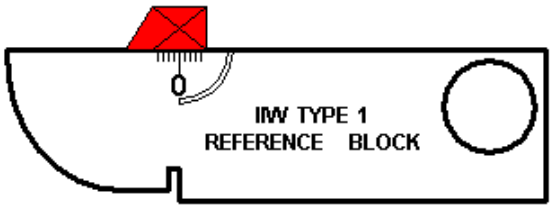


Figure 29 Reference Block Displaying the "0" Mark

2. Manipulate the probe until a high amplitude signal appears on the screen after the Main Bang. This is the reflection from the large arc of the block that is located on the Type I block at 4" (100 mm).
3. Move the probe forward and backward to bring the echo to its maximum amplitude (peak it up). Make sure the echoes do not exceed 100%. Reduce the Gain setting if necessary.

Note: The **Peak Memory** feature on the EPOCH LT is an excellent tool to aid in finding the BIP. Press **[PEAK MEM]** to turn on the feature. This feature draws and collects the echo envelope of the signal while also drawing the

live waveform. Match the live waveform with the maximum point corresponding to the previously accumulated echo dynamic curve. Refer to the figure above for a detailed schematic of using the **Peak Memory** feature to find the BIP. Press **[PEAK MEM]** again to turn off the feature.

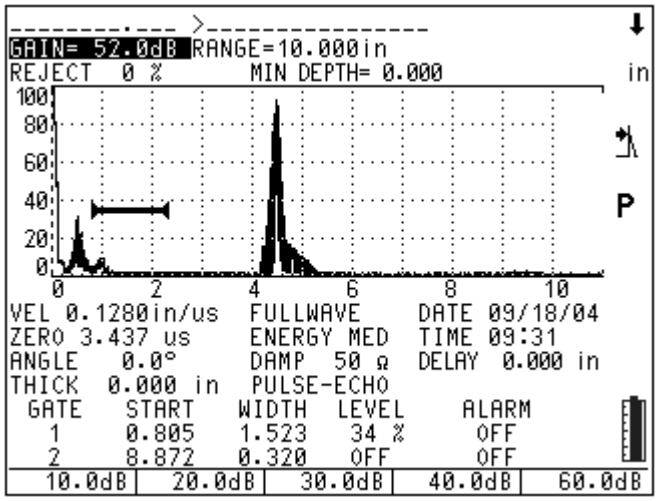


Figure 30 Locating the Beam Index Point

4. Hold the probe stationary once you have peaked up the signal and mark the side of the transducer wedge directly over the "0" mark on the block. This is the BIP – the point at which the sound leaves the wedge and enters the material with maximum energy.

7.5.2 Verifying the Refracted Angle (Beta)

The refracted angle of the probe should already have been previously entered into the EPOCH LT in the initial steps of the calibration procedure. Although the wedge may be marked 45^{o}, for example, the actual refracted angle may be slightly different due to the properties of the test material or the amount of wear on the wedge. It is necessary to verify the actual angle. This ensures the EPOCH LT's soundpath calculations are accurate.

To verify the refracted angle, follow these steps:

1. Position the probe over the appropriate angle mark on the block, which is 45^{o} for this example.

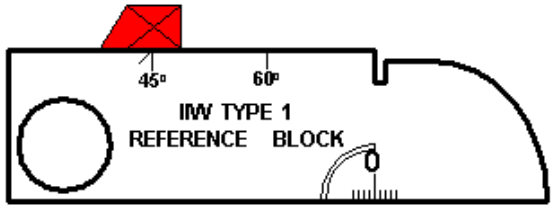


Figure 31 Verifying the Refracted Angle

2. Move the probe backward and forward to “peak up” the echo coming from the large circular hold in the side of the block. The circular hole may be filled with Plexiglas, but the procedure is the same.

Tip: The **Peak Memory** feature on the EPOCH LT is an excellent tool to aid in finding the peak of the signal.

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3. Hold the probe stationary once you have peaked up the signal. Note the degree mark on the block that lines up with the BIP, which you marked on the side of the wedge in the previous step. This is the actual refracted angle (Beta) for this particular transducer and wedge in steel.

   If this value for Beta differs from the value entered previously, enter the corrected angle now via the **[ANGLE]** key and the **[↑], [↓], [←],** and **[→]** keys.

7.5.3 Calibrating for Distance

Note: This step differs depending on which type of IIW calibration block is used. The ASTM E-164 IIW Type I Block, which has a crescent cut in the side, produces echoes at 4" (100 mm) and 9" (225 mm) on the screen. The U.S. Air Force IIW Type II Block, which has a large cutout in the side, produces echoes at 2" and 4" on the screen. The procedure below uses Panametrics-NDT™ IIW Type I carbon steel calibration block, part number TB7541-1.

We recommend that the EPOCH LT’s Range parameter be set to 10" (250 mm) for this step. Regardless of whether a Type I or Type II Calibration block is used, this should ensure that the echoes from the block are visible on screen.

To calibrate for distance, follow these steps:

1. Couple the probe to the block so that the BIP is directly over the “0” mark on the ASTM test block (or the Air Force block.) **Do not move the transducer from this point during this step.**
2. Press **[CAL]**. A Cal symbol appears to the right of the A-Scan, signifying the EPOCH LT is in **Auto-Calibration** mode. To exit **Auto-Calibration** mode at any point, press **[ENTER]**.

3. Position Gate 1 so that the echo reflection from the 4" arc is exceeding the gate threshold. This should be the first large echo after the Main Bang.
4. Adjust the gain setting so that the echo amplitude is approximately 80%. A thickness reading appears in large text above the A-Scan.

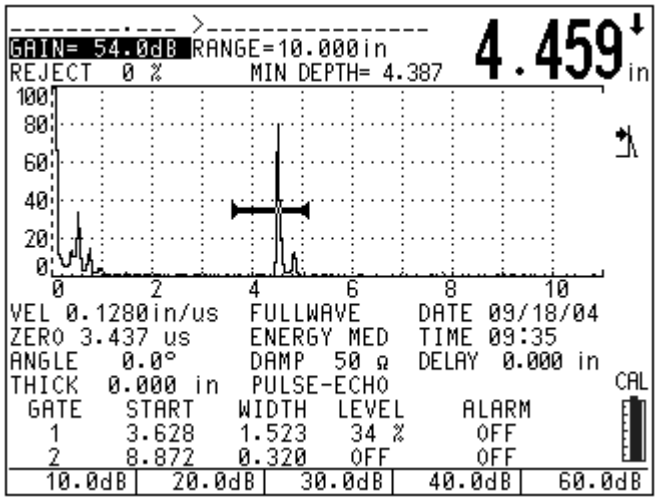

Figure 32 Calibrating for Distance

5. Press [**ZERO OFFSET**] once the reading is steady. The screen freezes and a pop-up box appears on the screen.

   Use the **[↑]** and **[↓]** slewing keys to enter the exact known thickness of the test sample.

Figure 33 Entering a Thin Standard Value

6. Press **[CAL]**. The display returns to the live A-Scan. Position Gate 1 so that the echo from the 1" crescent is exceeding the gate threshold. This echo is generally located at approximately the ninth or tenth screen division and usually the 3rd echo after the Main Bang.
7. Adjust the Gain setting so that this echo amplitude is approximately 40%. A thickness reading appears in large text above the A-Scan.

Note: Another echo may be present on the screen at approximately the eighth or ninth screen division. Disregard this echo as it is usually the result of beam

spreading and sound bouncing off the side of the block. Make sure Gate 1 is not over this echo.

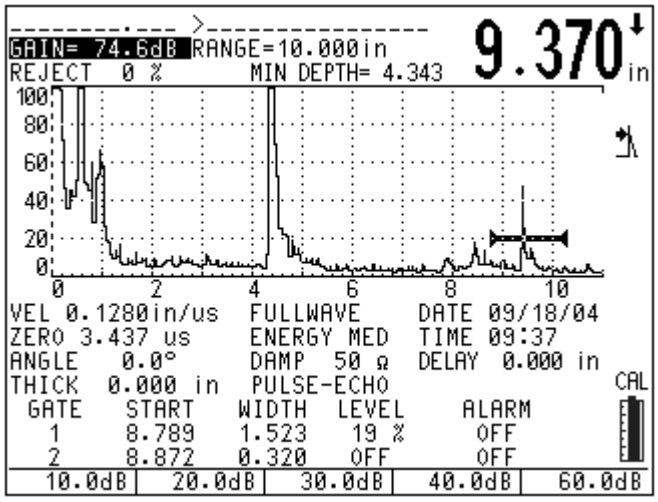

Figure 34 Adjusting the Gain

8. Press [**VEL**] once the reading is steady. The screen freezes and a pop-up box appears again on the screen.

   Use the **[↑]** and **[↓]** slewing keys to enter the exact known thickness of the test sample.

Figure 35 Entering a Thick Standard Value

9. Press [**ENTER**] to complete the **Auto-Calibration**. The **Zero Offset** and **Velocity** parameters adjust automatically, and the correct soundpath readings of any gated echoes are displayed on the screen.

7.5.4 Calibrating for Sensitivity

The final step in the angle beam calibration is to calibrate for sensitivity. This lets you set up a reference gain level.

1. Couple the probe to the IIW calibration block so that the transducer is aimed at the 0.060" diameter side drilled hole, which is used as a reference reflector.

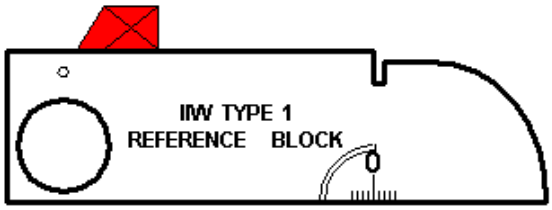

Figure 36 IIW Calibration Block with 0.060" Diameter Drilled Hole

2. Move the probe forward and backward until you have “peaked up” the return signal from the hole (that is, found the maximum amplitude).

Tip: The **Peak Memory** feature on the EPOCH LT is an excellent tool to aid in finding the peak of the signal.

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3. Adjust the system sensitivity (Gain) up or down once the echo is peaked up to bring the reference reflector signal to a predetermined reference line on the screen. In this example, the echo is brought to 80% of full screen height.
4. Press **[2nd F]**, **[GAIN] (REF)** to lock in the reference gain level and add/subtract scanning gain separately.
5. Press the function keys once the reference gain functions are activated to select between adding or subtracting in 0.1 dB or 6.0 dB increments.

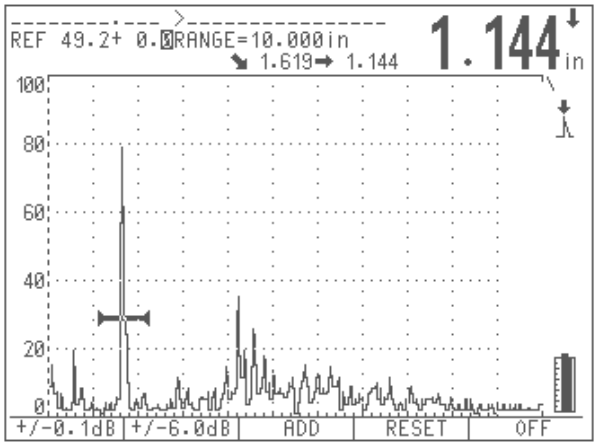

Figure 37 Locking the Reference Gain to Add/Subtract Scanning Gain

8 Managing the Datalogger and Data Communication Features

This chapter describes how to manage the EPOCH LT datalogger, which is designed for ease of use while providing a wide range of features for virtually all flaw detection and thickness gaging requirements. It includes the following capabilities:

- Data organized by file and identifier (ID) code
- Numeric file names and identifier codes
- On-screen scroll/review of file contents
- Ability to transfer data between the unit and a PC

Topics are as follows:

- Defining the Datalogger Storage Capacity
- Using the Memory Screen
- Entering Numeric File Names and ID Codes
- Creating New Files and ID Codes
- Saving Waveforms and Thickness Readings
- Incrementing ID Codes
- Recalling Transducer Calibrations and Waveforms

8.1 Defining the Datalogger Storage Capacity

The EPOCH LT datalogger stores the following data:

- **Thickness Reading**
  - Identifier (ID) code
  - Alarm conditions
  - Peak/Edge Depth Mode Indicator
  - Soundpath leg of measurement
  - Thickness/Soundpath values (**Edge** or **Peak Depth** mode), Current and Maximum Amplitude data (**Amplitude** mode), or Time-of-Flight data (**Microsecond** mode)
- **Complete Waveform/Parameter Setup**
  - All data listed in the **Thickness Reading** section
  - Waveform screen
  - Peak Memory echo envelope
  - Complete setup parameters

- Flag status (Freeze, Zoom, Peak Memory, etc.)

The EPOCH LT datalogger can store a maximum combination of 2,000 thickness readings or 100 waveforms.

Note: A software option is available to increase the storage capacity to 10,000 thickness readings or 500 waveforms. (See Expanded Memory on page 84.)

The EPOCH LT can save information in 500 separate files. Files 1-9 are fixed files, meaning that each file can only store one complete waveform/parameter setup with an associated identifier (ID) code. This structure allows you to easily create and recall transducer calibrations since each file can contain only one setup.

Files 10-500 are flexible files, which can store numerous thickness readings, waveforms, and memos. Thickness readings and waveform data can coexist in the same file. Calibration waveform/parameter setups can also be stored in these files and recalled to the live screen.

8.2 Using the Memory Screen

To enter the *Memory* screen, press **[2nd F](ID)**. The *Memory* screen is split into two windows.

- **Lower window:** displays a directory of files
- **Upper window:** displays the file contents

To toggle between the two windows, press **[F1]**. Other function key prompts appear when applicable.

The remaining available memory is displayed between the **File Content** and **File Directory** windows. Press **[F5]** to exit and return to the live screen.

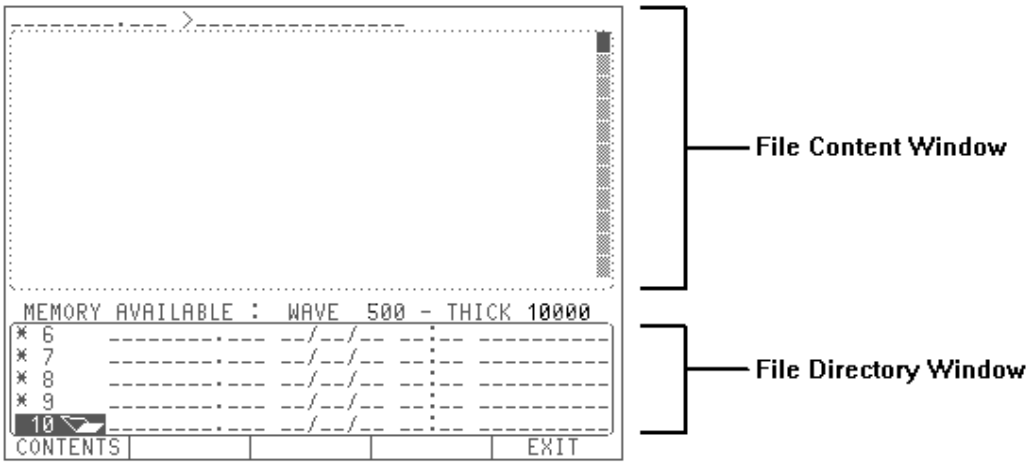

Figure 38 Memory Screen (no stored files)

8.3 Entering Numeric File Names and ID Codes

You can use the EPOCH LT datalogger for thorough documentation of inspection data. Enter a filename along with the date and time for each file to organize inspection data. Also, you can enter up to a 16-digit identifier string for each saved waveform or thickness measurement.

To enter numbers, follow these steps:

1. Use the up and down arrows to enter the numbers 0-9.
2. Use the left and right arrows to move to the previous or next space.

Tip: From the live A-Scan screen, use the function keys as shortcuts. For example:
F1: Enter any number between 0-9
F2: Move to the previous space
F3: Move to the next space
F4: Delete an entry
F5: Exit the screen

8.4 Creating Files and ID Codes

Thickness readings and waveforms are stored in the EPOCH LT datalogger in a file with an associated ID. You can either manually enter file names and IDs using the EPOCH LT's keypad, or create them in the GageView Interface Program and download them to the instrument. (Contact Panametrics-NDT™ or your local representative for more information on the GageView Interface Program.)

You can create file names in the EPOCH LT's *Memory* screen in preparation for saving thickness readings and waveforms. On entering the memory screen, a cursor appears at the first available empty file location. If the cursor is flashing over an existing file, use the down arrow key to move to the next available empty file location. You can enter a filename, date, and time.

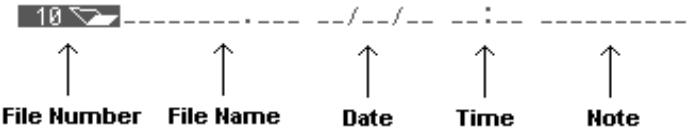

Figure 39 Entering File Information

The following rules and conditions apply:

- The file name is limited to eight characters with an extension of three characters. If no file name is assigned, the instrument automatically assigns a generic name FILENAME.001, FILENAME.002, and so forth.
- You can manually enter the date and time.

Once the file name is created, press [**DISPLAY**] to return to the live screen. Whatever file is open (designated by a flashing cursor) is the file that begins to have data saved to it when returning to the live A-Scan. The file name displays continually at the top left screen.

Before any data is stored in the file, press [**ID**] to enter the first Identification (ID) code. A cursor appears at the ID entry line at the top right side of the screen. Use the slewing keys or the function keys to enter the ID. To redo an entry, use the left arrow key to backspace or press [**ID**] a second time and a blank line will appear. To toggle back to the original ID, press [**ID**] again.

8.5 Saving Waveforms and Thickness Readings

Follow the steps outlined in Section 8.4 to setup a file name in the *Memory* screen and an Identifier (ID) file in the live screen.

The EPOCH LT can save two types of data:

- **Thickness Readings:** Press **[SAVE THICK]** to save the ID code along with the displayed depth, amplitude, or TOF value. The waveform and the setup parameters will **NOT** be saved during this process and these IDs **CANNOT** be recalled to the live screen. Saving this limited data allows the EPOCH LT to store a larger number of individual IDs and corresponding measurement values (2,000 readings or 10,000 readings with the Expanded Memory option).
- **Waveforms:** Press [**SAVE WAVE**] to save all waveform data and setup parameters in the datalogger. These IDs can be recalled to the live screen to restore the instrument's settings to what they were when the calibration/waveform was initially saved. The EPOCH LT can save a total of 100 (500 with the Expanded Memory option) complete waveform/parameters setups.

Data is saved in the EPOCH LT datalogger in the currently displayed file and tagged with the ID code displayed on the screen. The ID code automatically increments to the next ID in preparation for saving additional data. (See Incrementing ID Codes on page 75.)

To save thickness readings and waveforms to a different file already created in the EPOCH LT or a completely new file, return to the *Memory* screen and position the highlight bar over the desired filename (or on a newly created filename.) When you return to the live screen, the EPOCH LT saves data at whichever file was highlighted when the *Memory* screen was exited. The file name is also displayed on the top left of the live screen.

Note: Every time the EPOCH LT is initially turned on, the next available blank file is displayed. The top left portion of the screen displays a blank line indicating that no file has been selected. If you enter an ID and then attempt to start saving data, the EPOCH LT automatically creates a new file name where the data is stored. The file is named FILENAME.XXX, where the extension incrementally increases depending on the number of untitled files created.

8.6 Incrementing ID Codes

This feature automatically increments the EPOCH LT's ID code every time you press the **[SAVE THICK]** or **[SAVE WAVE]** key. You do not have to enter a new ID every time a reading is saved. For example, a user wants to save several readings when inspecting an aircraft wing. Begin by entering an initial ID of "01." Press **[SAVE THICK]** or **[SAVE WAVE]** to save desired thickness readings and waveforms. Every time you press one of these keys, the ID code listed at the top of the screen increments by one character value. In this example, the first thickness reading/waveform is saved with an ID code of "01," the second one with an ID code of "02," and so on.

Some guidelines for the auto-ID incrementing features are:

- Only the portion of the ID consisting of digits and letters (no punctuation marks) beginning with the rightmost letter and extending leftward to the first punctuation mark or leftmost character (whichever comes first) is incremented.
- To have the EPOCH LT properly increment, first create and hold using zeros the maximum number of needed digit positions. To save 999 readings, enter "001" as the first ID code. If an initial ID code of "1" is entered, the EPOCH LT only increments up to "9" and beeps. The message error – "Id Cannot Increment" appears. Press [**F1**] to exit and enter a new ID code to continue saving readings.
- After saving several readings to a file, you may want to save data to a different file. If you return to a file where data has already been saved, the ID code displays the next available ID (incremented after the last save).
- To interrupt the auto-ID sequencing, press the [**ID**] key and enter a new ID code. The new ID code then increments in the same fashion.

Note: It is possible to create a list of ID's in the GageView Interface Program and then transmit this list to the instrument. When you select this file to save information, the unit automatically begins to incrementally fill the ID database created in the PC. Contact Panametrics-NDT™ or your local representative for details regarding ordering the GageView Interface Program.

8.7 Recalling Transducer Calibrations and Waveforms

The EPOCH LT datalogger is designed to let you quickly review the contents of saved files, and then recall saved transducer calibrations to the live screen.

To recall a saved calibration, follow these steps:

1. Press the **[2ndF](ID)** to enter the *Memory* screen.
2. Use the slewing keys to select the file where the desired calibration is located.
3. When the file is highlighted, press [**F1**] to enter the *Contents* screen.
4. Use the slewing keys to scroll through the selected file. Only IDs with saved waveform/parameter setups can be recalled to the live screen. The ID name being

viewed displays at the top of the screen As you scroll through the file, this ID will continually change.

a. When an ID is listed that has a corresponding waveform and setup parameters saved with it, a **Recall** selection is available by pressing [**F2**].

b. The **Recall** selection disappears when an ID is listed that contains a measurement value only (depth, amplitude, or TOF).

5. Press [**F2**] for **Recall** when the appropriate ID is listed at the top of the screen. The calibration is recalled and the EPOCH LT is in the **Freeze** mode. You cannot change any parameters while in **Freeze** mode.
6. Press **[FREEZE]** to go to the live screen. The EPOCH LT is ready for use with the same parameter settings used when this calibration was initially saved.

9 Using Software Options

This chapter describes the different software options available for the EPOCH LT. The EPOCH LT is intended to be a highly versatile instrument. It is capable of being configured to perform specialized functions related to certain applications or code requirements. Because some inspectors may not make use of these functions, these functions are offered as software options. Contract Panametrics-NDT™ or your local representative for information on ordering these options.

Topics are as follows:

- Defining Active/Inactive Options
- Distance Aplitude Correction (DAC)
- Time Varied Gain (TVG)
- Low Pulse Repetition Frequency (PRF)
- Expanded Memory
- Echo-to-Echo Measurement Mode
- Extended Range
- Curved Surface Correction (CSC)
- AWS D1.1/D1.5

9.1 Defining Active/Inactive Options

Software options are accessed using the [**OPTION**] key. The menu displays a list of available options, each with a triangle or box preceding it. The following table describes each symbol:

Symbol	**Description**
Unfilled triangle (▷) or box (□)	The option is not activated.
Filled triangle (▶)	The option is active. To activate an option, move the highlight bar over a desired selection using the slewing keys and press [**ENTER**].
Filled box (■)	The option is active, and no further adjustment is necessary.

Table 5 Active/Inactive Software Options

9.2 Distance Amplitude Correction (DAC)

A Distance Amplitude Correction (DAC) curve is used to plot amplitude variations of signals from reflectors of the same size, but at different distances from the transducer. Normally, these reflectors produce echoes of varying amplitude due to material attenuation and spreading of the sound beam. The purpose of a DAC curve is to graphically compensate for material attenuation, nearfield effects, beam spread, and surface roughness.

After plotting a DAC curve, reflectors that are the same size as those used for creation of the curve produce echoes that peak along the curve despite different locations in the test piece. Similarly, reflectors that are smaller than those used to create the curve fall below the level, while larger reflectors exceed the curve level.

With the use of the DAC curve option, the EPOCH LT is capable of drawing user-defined DAC curves. It is possible to select formats that are consistent with either ASME, ASME-3, or JIS Z3060 code requirements.

When the ASME format is selected, a single curve is drawn. The ASME-3 format lets you draw three curves simultaneously at 0 dB, –6 dB, and –12 dB. When the JIS format is selected, up to eight segmented curves are drawn.

In all formats, the signal amplitude as a percentage of the primary curve level is displayed on the screen. Users can select to view this value in terms of a "%" or "dB." In addition, DAC alarms can be set to activate whenever an echo exceeds the primary curve level. DAC curves can be saved in the EPOCH LT datalogger and recalled when needed.

9.2.1 Drawing DAC Curves

To draw a DAC curve, follow these steps:

1. Calibrate the EPOCH LT for the appropriate transducer. Adjust the Gain so the peak of the highest amplitude echo that is to be used in the DAC curve is visible on the screen. An echo cannot be used in the curve if its amplitude is greater than 100% screen height.
2. Press [**OPTION**].
3. Use the slewing keys to position the highlight bar over the DAC selection, and press [**ENTER**] to display the DAC setup choices.
4. Use the slewing keys and the [**ENTER**] key to select the DAC standard (ASME, ASME-3, or JIS) and the signal amplitude units (% DAC or dB DAC).
5. Press [**OPTION**] to return to the A-SCAN display.
6. Position Gate 1 over the desired echo to begin drawing the DAC curve. Adjust the gate level if necessary to make sure the echo breaks the gate. Press [**F1**].
7. Move Gate 1 to the appropriate position to capture the next point for the curve.
8. Press [**F1**]. Repeat this step until all points for the curve are captured.
9. Press [**F2**] to complete the curve once the last point is captured.

Tip: To correct a mistake made while drawing the curve, press [**F3**] to clear the curve and start again.

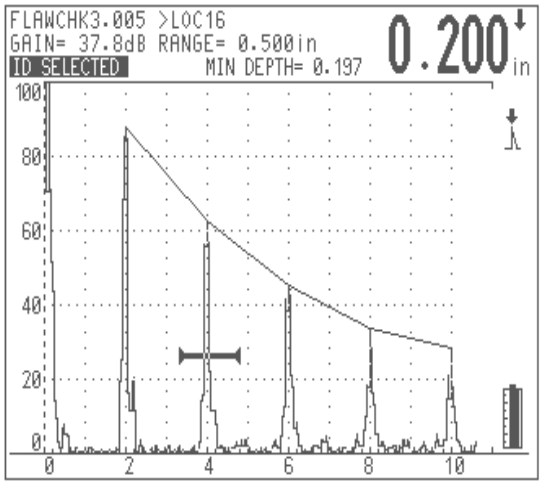

Figure 40 Creating a DAC Curve

When the **DAC** mode is active, any parameter that would affect instrument calibration is automatically locked. This includes: [**GAIN**], [**RANGE**], [**ZERO OFFSET**], [**VELOCITY**], [**ANGLE**], [**REJECT**], and all pulser and filter parameters.

To obtain amplitude information in the **DAC** mode, press **[DEPTH /%AMP]**, and [**F3**]. If you highlight the **% DAC** selection in the DAC setup screen, the EPOCH LT displays the current echo height percentage (in terms of full screen height) and the percentage of the echo related to the primary DAC curve level. If **DB DAC** is selected, the current echo height percentage (in terms of full screen height) and the dB value of the echo related to the primary DAC curve level are displayed.

Once the curve is complete, the Reference Gain function can be activated by pressing **[2nd F**], [**GAIN**] (**REF DB**). This key sequence locks in a reference gain level and allows scanning gain to be added or subtracted to accommodate specific applications. For example, if it is required to evaluate any reflector that exceeds 50% of the DAC level, 6 dB of scanning gain can be added. In this manner, the DAC curve when used in conjunction with the Amplitude DAC display and DAC alarm becomes an easy reference to determine if an indication exceeds the evaluation level. Note that the additional scanning gain cannot be added to the original reference gain level as this would change the calibration and invalidate the DAC curve.

Note: The **Zoom** function is active after setting up a DAC curve. When zooming in on a particular echo, the DAC curve temporarily disappears. The curve reappears when zooming back out. The A Scan waveform can also be saved when in the **Zoom** mode, however, the DAC curve is not saved with the waveform.

9.2.2 Special Considerations for JIS Z3060 DAC Curves

In general, the instructions in Section 9.2.1 apply to the construction of all DAC curves. However, there are some special provisions that have been made to address the requirements of JIS Z3060. These considerations are listed below.

- Because of the large number of curves drawn for the **JIS DAC** mode, it is possible to temporarily add 6, 12, 18, or 24 dB of additional gain while constructing the DAC curve set. The purpose of this feature is to facilitate construction of additional curves when testing at longer ranges. Once construction of the curve set has begun, add up to 24 dB of additional gain through repeated presses of the [**GAIN**] key. In order to make clear that gain has been added while constructing the curve, the gain appears as follows: "GAIN 46.2 dB + 6," "GAIN 46.2 dB + 12," etc. Once the curve set is completed, the gain is reset to its original level (46.2 dB in this example).
- It is possible to change Angle, Material Thickness, Zero Offset, and Gain in the normal manner when in the **JIS DAC** mode. Be careful when adjusting these parameters to ensure that the relationship of DAC curves to material thickness or distance is not unintentionally altered.
- Any of the six curves can be used to trip the alarm when in the **JIS DAC** mode. Additionally, you can set the alarm to positive or negative. To select which curve will be used as the alarm reference level, first activate JIS DAC and then use the **[F4]** and **[F5]** function keys to select which curve to use for the alarm threshold. The selected curve appears as a double thickness line. Once a curve has been selected, an alarm can be activated and set to be either positive or negative threshold detection by pressing **[2nd F**], [**GATE 1**] (**ALARM 1**) and following the prompts.
- When the **JIS DAC** mode is active, the amplitude (level) of a gated signal is always displayed as a percentage (% DAC or dB DAC) with respect to the selected curve. If a different curve is selected, the displayed amplitude changes accordingly.

9.2.3 Saving and Recalling DAC Curves

DAC curves are saved and recalled in the same manner as any general waveform/ calibration. With **DAC** mode active, use the [**SAVE WAVE**] key to save the entire setup in the datalogger. When a setup that was stored with a DAC curve is recalled, the instrument automatically comes up in the **DAC** mode.

9.2.4 Setting Alarms in DAC Mode

You can use the gates to set alarms while DAC is active. When using the ASME or ASME-3 DAC modes, all alarms are referenced to the primary curve. When using the **JIS DAC** mode, alarms are referenced to the highlighted alarm curve. For example, any DAC alarm can be set by using the positive threshold alarm on either Gate 1 or Gate 2. Any echo that falls within the gate and exceeds the DAC level triggers the alarm. The alarm is triggered only if an echo exceeds the portion of the DAC curve immediately above the gate. This same rule applies to the use of the minimum depth and negative threshold alarms while in DAC.

Note: Alarms do not function in the area outside of the DAC curve.

9.2.5 Exiting DAC Mode

To clear the DAC curve and return to the normal operation, follow these steps:

1. Press [**OPTION**].
2. Use the slewing keys to highlight the **DAC** selection and press [**ENTER**] to go into the DAC setup.
3. Use the slewing keys to highlight **Off** and press [**ENTER**].
4. Press [**OPTION**] to return to the A-Scan display.

9.3 Time Varied Gain (TVG)

The Time Varied Gain (TVG) option compensates for the changes in echo amplitude from equal sized reflectors at different distances due to material attenuation and beam spreading. When TVG is properly set up, equal sized reflectors produce indications of equal screen height regardless of their distance from the transducers. TVG has a dynamic range of 40 dB with a minimum echo height of approximately 5%.

Note the following items when using the TVG option:

- TVG is active in all display modes (RF, Full Wave, Half Wave +, and Half Wave -).
- TVG and DAC may not be activated simultaneously.
- Up to 20 TVG calibration points may be programmed, separated by a minimum of 0.52 microseconds (approximately 0.06" or 1.5 mm at longitudinal velocity in steel).
- The minimum full screen range must be set greater than approximately 1" (25 mm) at longitudinal velocity of steel to activate TVG. After a TVG curve is set up, it is possible to zoom in to smaller ranges than 1.000 inches.
- The maximum full screen range must be set less than approximately 120" (3050 mm) at the longitudinal velocity of steel to activate TVG.
- TVG must be set up with the aid of reference standards that generate representative echoes at the points of interest.

9.3.1 Activating and Calibrating TVG

To activate and calibrate TVG, follow these steps:

1. Calibrate the EPOCH LT for the appropriate transducer.
2. Adjust the Gain so the peak of the highest amplitude echo to be used in the TVG setup is visible on the screen. An echo cannot be used at a TVG point if its amplitude is greater than 100% screen height.
3. Press [**OPTION**] to display the **Options** menu.
4. Use the slewing keys to position the highlight bar over the TVG selection, and press [**ENTER**] to display the TVG setup choices.
5. Use the slewing keys and the [**ENTER**] key to select **On**.

6. Press [**OPTION**] to return to the A Scan display.
7. To set a TVG point, position Gate 1 over the desired echo. Adjust the gate level if necessary to make sure that the echo breaks the gate. Press [**F1**]. Generally, you should start with the highest amplitude calibration echo and work down to the smallest one.

   You can go back to fine tune the gain level at any selected point by repositioning the gate on the appropriate echo and pressing **[F1]** again. If a point is outside the allowable time limits, the unit beeps to indicate an error.
8. Move Gate 1 to the appropriate position to capture the next point for the curve and press [**F1**] again. Repeat this step until all points for the curve are captured.
9. Press [**F2**] when all echoes have been set to lock the TVG setup. The letters “TVG” will appear to the right of the screen to indicate that TVG is active. A double thickness line appears at the top of the display to mark the area over which TVG has been programmed.

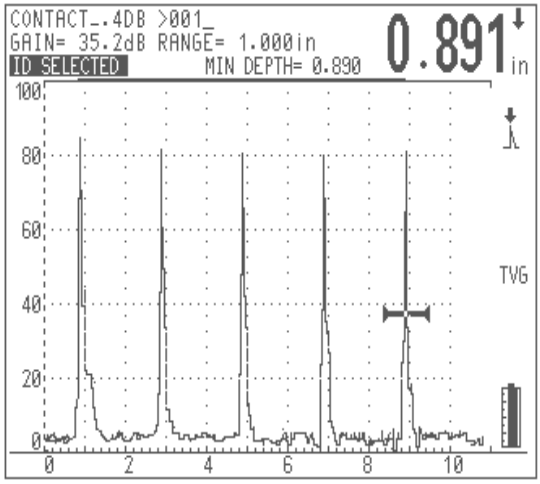

Figure 41 TVG Example

When **TVG** mode is active, any parameter that would affect instrument calibration is automatically locked. This includes: [**GAIN**], [**ZERO OFFSET**], [**VELOCITY**], [**ANGLE**], [**REJECT**], and all pulser and filter parameters.

Once the TVG setup is complete, you can activate the Reference Gain function by pressing **[2ndF]**, [**GAIN**] (**REF DB**). This locks in a reference gain level and allows scanning gain to be added or subtracted to accommodate specific applications. Note that the additional scanning gain cannot be added to the original reference gain level as this would change the calibration and invalidate the TVG setup.

9.3.2 Saving and Recalling TVG Setups

TVG setups are saved and recalled in the same manner as any general waveform/ calibration. With **TVG** mode active, the [**SAVE WAVE**] key is used to save the entire

setup in the datalogger. When a setup that was stored with a TVG setup is recalled, the instrument automatically comes up in **TVG** mode.

9.3.3 Exiting TVG Mode

To clear the TVG setup and return to the normal operation, follow these steps:

1. Press [**OPTION**].
2. Use the slewing keys to highlight the **TVG** selection and press [**ENTER**] to go into the TVG setup.
3. Use the slewing keys to highlight **Off** and press [**ENTER**].
4. Press [**OPTION**] to return to the A Scan display.

9.4 Low Pulse Repetition Frequency (PRF)

Pulse Repetition Frequency (PRF) is a measure of how often the transducer is being pulsed by the electronic circuitry in the EPOCH LT. The standard PRF setting of the EPOCH LT is “Auto,” where the PRF changes automatically from 60 Hz to 180 Hz depending on the range setting.

For some applications, it may be necessary to lower the PRF rate below 60 Hz to avoid a phenomenon known as “wrap-around noise.” This can sometimes occur when testing long soundpaths and can result in random noise and echoes on the A Scan display. When the Low PRF option is activated, the EPOCH LT maintains a fixed PRF of 30 Hz.

9.4.1 Activating Low PRF Mode

To activate the **Low PRF** mode, follow these steps:

1. Press [**OPTION**].
2. Use the slewing keys to highlight the **PRF** selection and press [**ENTER**].
3. Use the slewing keys to highlight **LOW** and press [**ENTER**].
4. Press [**OPTION**] to return to the A Scan display. A “PRF” symbol displays on the right side of the screen to indicate that the **Low PRF** mode is enabled.

9.4.2 Exiting Low PRF Mode

To exit the Low PRF mode, follow these steps:

1. Press [**OPTION**].
2. Use the slewing keys to highlight the **PRF** selection and press [**ENTER**].
3. Use the slewing keys to highlight **Off,** and press [**ENTER**].
4. Press [**OPTION**] to return to the A Scan display.

9.5 Expanded Memory

The standard datalogger capacity in the EPOCH LT allows for a combination of 100 waveforms/calibrations or 2,000 thickness readings. The Expanded Memory option provides the EPOCH LT with a total capacity of 500 waveforms/calibrations or 10,000 thickness readings.

If an EPOCH LT is purchased with the Expanded Memory option, there is no further setup that is required by you. The instrument's datalogger is simply able to store more information before reaching its capacity.

To confirm that the Expanded Memory option is active in a particular EPOCH LT, press the [**OPTION**] key. If the **Expanded Mem** selection has a filled-in box next to it, the option is active.

Note: To determine the remaining capacity in the EPOCH LT datalogger, press **[2nd F](ID)** to enter the datalogger screen. The remaining number of waveforms or thickness readings that can be saved is displayed in the center of the screen.

9.6 Echo-to-Echo Measurement Mode

Using the Echo-to-Echo software option, you can make measurements between successive echoes. Measurements can be made between two consecutive backwall echoes or between an interface echo and any other selected signal. This provides the capability to measure thickness through coatings or to do low speed immersion testing. A second gate (Gate 2) is used to capture data from the second backwall echo. Echo-to-Echo readings are made by calculating the separation between the detected echoes in Gate 1 and Gate 2.

Echo-to-Echo thickness readings cannot be made in the unrectified RF display mode.

Calibrate the EPOCH LT and follow these steps to make Echo-to-Echo thickness readings. (See Calibrating the EPOCH LT on page 55 for more detail about calibration.)

1. Position Gate 1 over the region where the first backwall echo is expected to appear.
2. Press **[2nd F], [DEPTH/%AMP] (ECHO-ECHO)** to activate the optional **Echo-to-Echo** measurement mode. The following will appear in the function boxes at the bottom of the display.

   F1 = EDGE, F2 = PEAK

3. Select either edge-to-edge or peak-to peak. The icon appears for peak-to-peak or appears for edge-to-edge to the right of the display to indicate Echo-to-Echo measurements are being used.

   If Gate 2 is off and the optional **Echo-to-Echo** mode is turned on, then Gate 2 is automatically turned on.

4. Define the Blanking Period to avoid possible false readings that could occur due to transducer ringing or material noise. A dead zone or blanking period is necessary after

the detection of the first echo. This period is defined during set-up as the separation between the start of Gate 1 and the start of Gate 2. When an echo is detected in Gate 1, Gate 2 start automatically adjusts to trail the detected echo by the blank period.

For example, if Gate 1 Start is set to 0.25" (6.35 mm) and Gate 2 Start is set to 0.40" (10 mm), then the blank period is 0.15" (3.8 mm) of metal path. If the first detected echo breaks Gate 1 at 0.35" (8.9 mm), then Gate 2 Start automatically adjusts by the value of the blanking period to 0.50" (0.35" + 0.15") or 12.7 mm (8.9 mm + 3.8 mm).

There is a trade-off in defining the blanking period. While a relatively long period may prevent false readings, the minimum measurable thickness is limited to a value slightly greater than the blanking period.

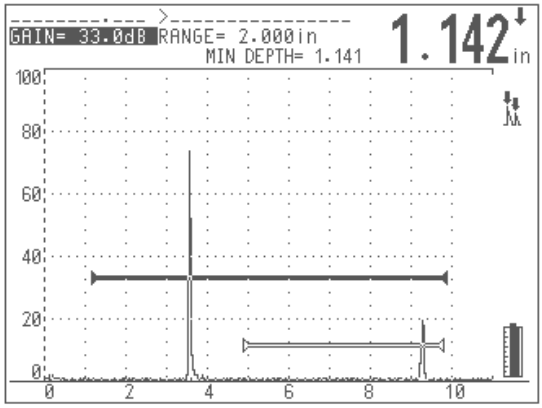

Figure 42 Set-up for Peak-to-Peak Measurement

9.7 Extended Range

The standard EPOCH LT has a range of 0.16" to 200.00" (4 mm to 5,000 mm). With the Extended Range option, the instrument range is increased to 0.038" to 400.00" (1 mm to 10,000 mm).

Extended Range is a factory-installed software option. Once this option is activated, you cannot turn it on and off. To verify that an EPOCH LT is equipped with Extended Range, press the **[OPTION]** key. If the square next to the **Extended Range** option is filled (■), then the instrument is equipped with this option; if the square is empty (❑), then the instrument is not equipped with this option.

9.8 Curved Surface Correction

The Curved Surface Correction (CSC) option for the EPOCH LT is used to provide accurate sound path values when inspecting curved surfaces such as pipes. When you enter the pipe diameter and thickness, soundpath information is adjusted accordingly when using an angle beam probe to inspect the circumference of the curved surface.

1. Press [**OPTION**].
2. Use the slewing keys to highlight CSC from the menu and press [**ENTER**].

   An ☒ appears, indicating that the CSC option is active. A cursor will appear over the outer diameter value.
3. Use the slewing keys to enter the desired diameter.
4. Press [**F1**] and then **[OPTION]** to return to the live screen. A CSC prompt is displayed to the right of the A Scan whenever the EPOCH LT is in **CSC** mode.
5. Calibrate the EPOCH LT and be sure to enter the appropriate shear wave angle. Correct soundpath information is displayed when an echo breaks a gate.

Note: The CSC option is linked to the EPOCH LT memory. If a calibration or waveform is saved in **CSC** mode, the instrument will be in CSC mode when that data set is recalled. A "c" is displayed in the *Memory* screen after the ID to signify the calibration or waveform was saved in **CSC** mode.

6. Press [**OPTION**] and highlight CSC to exit **CSC** mode.
7. Press [**ENTER**] to bring up the **CSC** setup menu.
8. Press [**ENTER]** to disable the option and deselect the check box.
9. Press [**F1**] to return to the **Option** menu.

9.9 AWS D1.1/D1.5

The AWS D1.1/D1.5 software option for the EPOCH LT assists with performing inspections covered under the American Welding Society D1.1 Structural Welding Code for steel. This code provides inspectors with a method to classify discontinuities found in welds.

This code uses the following formula to develop an indication rating for a reflector found during an inspection:

A – B – C = D

where:

A = Discontinuity Indication Level (dB)

B = Reference Indication Level (dB)

C = Attenuation Factor: 2*(soundpath in inches – 1 inch) (dB)

D = Indication Rating (dB)

An AWS D1.1 inspector must take the Indication Rating (D) that is calculated based on A, B, and C to an *Ultrasonic Acceptance – Rejection Criteria* table produced by the AWS in order to classify the severity of the discontinuity that has been located. When performing an inspection, you are required to develop an AWS report that lists the values for all variables listed above as well as transducer information, discontinuity length and location, and your overall evaluation of the discontinuity.

For further details regarding the test equipment, methods, interpretation, and classification requirements for these inspections, refer to the AWS D1.1 Code Book.

9.9.1 AWS D1.1 and the EPOCH LT

Panametrics-NDT™ developed the AWS D1.1 software option for the EPOCH LT to simplify your tasks and lower overall inspection time. This is accomplished by having the EPOCH LT perform some required calculations automatically and also by allowing you to document discontinuities in the EPOCH LT's datalogger for reporting purposes.

The EPOCH LT can also transfer inspection data to the GageView Interface Program to aid in report generation. This program allows you to view the instrument setup parameters, the waveform generated by a discontinuity, the discontinuity's soundpath and location information, and all values for the AWS D1.1 formula variables.

9.9.2 Operating the AWS D1.1 Software

The first step in operating the EPOCH LT for AWS D1.1 inspections is to calibrate the instrument for the transducer and test conditions.

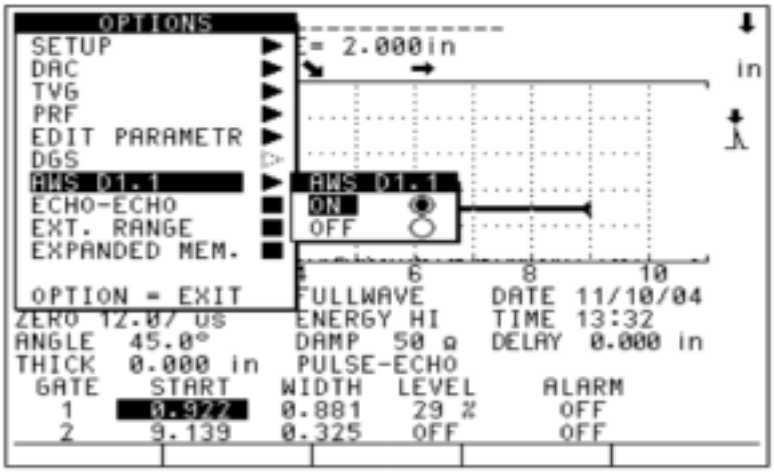

Figure 43 AWS D1.1 Software Option Activated in the Options Menu

When AWS D1.1 is activated, the EPOCH LT function keys provide the following options:

[F1]: REF B – store the dB value from a reference reflector

[F2]: No Function

[F3]: No Function

[F4]: SCAN DB – toggle the scanning gain between a selected value and zero dB

[F5]: AUTO-80 – adjust a gated signal to 80% FSH

After the AWS option is activated from the **Options** menu, you must set a REF B value in order to begin an inspection. This number represents the gain level necessary to bring the echo from a reference reflector to 80% Full Screen Height (FSH). The reference reflector is often a side drilled hole in the calibration block used for the angle beam calibration. Other reference reflectors may be used provided that they meet AWS requirements for these inspections.

In order to store a REF B value, you must gate the echo from the reference reflector and bring the echo to 80% FSH. You can achieve this by pressing the **[GAIN]** key and adjusting the gain with the Up and Down arrow keys or by pressing **[F5]** to automatically adjust the gain to bring the echo to 80% FSH. Once the echo has the appropriate amplitude, press **[F1]** and the following screen will appear:

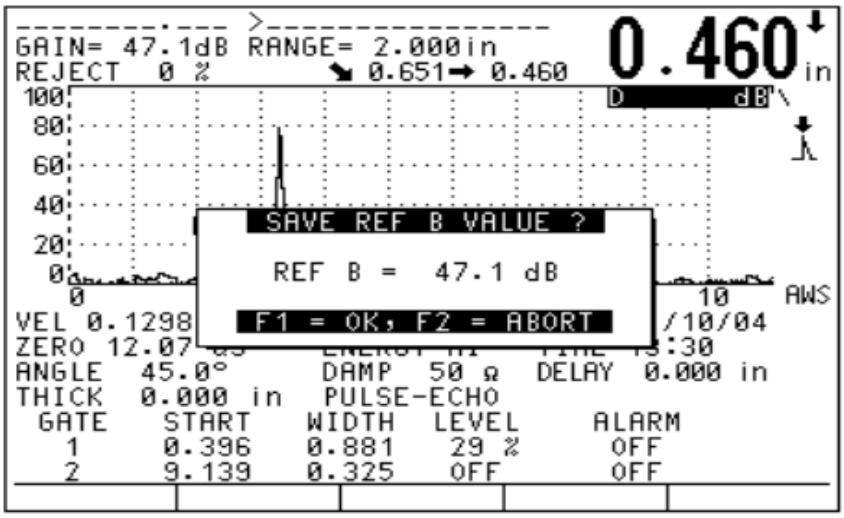

Figure 44 Pressing [F1] to Store the REF B Value

9.9.3 Adding Scanning Gain

AWS codes require that an operator enter a certain amount of scanning gain to the REF B dB value allowing the operator to locate flaws that may be smaller or deeper into the test piece than the reference flaw. By pressing **[F4]**, you can enter the amount of scanning gain necessary to perform the inspection as outlined by AWS code.

The EPOCH LT allows scanning gain to be entered in increments of 0.1 dB and 6.0 dB by default. However, you can customize these settings by using the Editable Parameters feature that is included with all EPOCH LT instruments. This feature is located in the **Options** menu, and there are on-screen prompts explaining how to adjust the preset values. Once the scanning gain is setup, press **[F4]** to toggle the scanning gain On and Off as necessary.

When a discontinuity is located within the test piece, the EPOCH LT provides a D value corresponding to the discontinuity. However, in order to display a D value, the gated echo must peak at an amplitude less than 100% FSH. Often, you will have to press **[F4]** to turn off scanning gain and bring the echo peak onto the screen. In some cases, further gain adjustments are necessary.

9.9.4 Calculating A and C Values

When a gated echo has a peak below 100% FSH, the EPOCH LT automatically calculates the A and C values necessary to provide a D value. In order to calculate the A value, the EPOCH LT automatically calculates the required dB value to bring the gated echo to 80% FSH. In order to calculate the C value, the EPOCH LT uses the data in the soundpath calculator to generate an attenuation factor.

Note: For this calculation to be accurate, you must enter the correct thickness for the test piece. The EPOCH LT displays the value for D in the upper right portion of the A Scan waveform display.

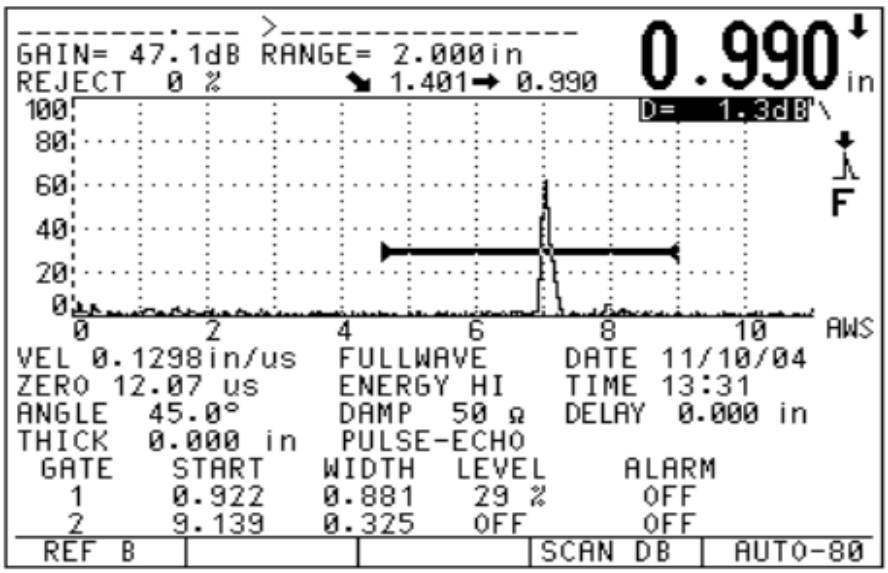

Figure 45 Displaying the D Value

Pressing the **[SAVE WAVE]** key saves the data for this discontinuity in the EPOCH LT datalogger.

Note: While using the EPOCH LT and the AWS D1.1 software option, you must be aware of any inspection conditions that may cause variation in the displayed Indication Rating (D value). You must also be able to interpret the meaning of echo indications and reported D values corresponding to these indications properly.

Appendix A – Specifications

DISPLAY	320 pixels (W) x 240 pixels (H) Liquid Crystal Display (LCD). “Split-screen” allows simultaneous viewing of waveform and setup data. Selectable “filled” or outline waveform trace.
GRATICULE	Electronically generated 2.625" x 2.375" (67 x 60 mm). No parallax error. No changes in brightness due to repetition rate changes.
DISPLAY UPDATE RATE	Minimum 60 Hz under all test conditions.
SENSITIVITY	100.0 dB max. and reference level sensitivity feature with 6 dB or 0.1 dB selectable resolution.
SELF CALIBRATION	Continuous, automatic self-calibration compensates pulse amplitude and receiver sensitivity for temperature and aging effects.
AUTO CALIBRATION	Automatic calibration of Zero Offset and/or Velocity.
REJECT	Absolutely linear from 0% to 80% full scale in 1% increments.
UNITS	English, metric, or microseconds.
MATERIAL VELOCITY	0.025 to 0.6000 in/μsec (635 to 15240 m/s). Switchable between two stored velocity settings.
ZERO OFFSET	0 to 350 μsec.
RANGE	0.160" – 200" (4 – 5,000 mm) standard range at the velocity of longitudinal waves in steel. Optional 0.04"– 400" (1 – 10,000 mm).
DISTANCE READOUT	Provides single echo or optional Echo-to-Echo thickness readings (in large numerals) or soundpath, surface and depth display for angle beam testing. Measures to either peak or leading edge of gated signal. In addition, selectable microsecond readout for time-of-flight measurements.
REFRACTED ANGLE	Fixed settings of 0^o, 30^o, 45^o, 60^o, 70^o, or variable from 10^o to 85^o in. 0.1^o resolution.
GATE START	Variable over entire displayed range.
GATE WIDTH	Variable from Gate Start position to the maximum displayed range.
GATE LEVEL	**Off** or **On** with level adjustable from 2% to 95% of full screen in 1% increments for both **Rectified** and **RF** display modes.

ZOOM	Expands gated portion of display to full screen width.
PEAK MEMORY	Simultaneous display of live A Scan and peak envelope of A Scan display with peak hold reference.
SCREEN FREEZE	Freezes and holds waveform and soundpath display. Gates and thickness can be adjusted after the display is frozen.
PULSER TYPE	Negative spike or square wave tunable excitation.
PULSE ENERGY	Selectable: Low, Medium, High, or Max.
DAMPING	Selectable settings of 50, 63, 150, or 400 ohms.
RECTIFICATION	Full wave, half wave positive or negative, and unrectified RF settings.
ANALOG BANDWIDTH	Broadband, 20 MHz at –3 dB.
TEST MODES	Pulse Echo, Dual, or Through-Transmission.
ALARMS	Selectable threshold positive/negative or Minimum Depth modes.
MEMORY	Storage of up to 100 waveforms or 2,000 thickness readings. Expanded memory to 500 waveforms or 10,000 thickness readings.
IDENTIFIERS	16 numeric location codes.
OPERATING TEMPERATURE	0^{o} C to 50^{o} C (32^{o} F to 122^{o} F).
STORAGE TEMPERATURE	-20^{o} C to 50^{o} C (-4^{o}F to 122^{o} F) with battery. -15^{o} C to 60^{o} C (5^{o} F to 140^{o} F) without battery.
POWER REQUIREMENTS	AC Mains; 100-120 VAC, 200-240 VAC, 50-60 Hz.
BATTERY	Internal rechargeable NiMH battery back.
BATTERY OPERATING TIME	6-8 hours nominal.
BATTERY RECHARGE TIME	2.5 hours typical.
BATTERY STATUS	Continuously displayed, low battery warning display when battery life falls below one-half hour.
TRANSDUCER CABLE CONNECTORS	00 Lemo.
KEYPAD	English or International symbols.
LANGUAGES	Keypad selectable English, French, German, Japanese, Spanish, Italian, Russian, and user customizable languages available (Custom option not active).
USB COMMUNICATIONS	

PORT	USB 2.0 port for high speed data transmission between the EPOCH LT and a PC.
DIMENSIONS	9.375" H x 5.45" W x 1.5" T
WEIGHT	2.35 lbs (1.0 Kg)
WARRANTY	One year warranty, battery not included. Optional second year warranty available.

Appendix B – Sound Velocities

The following table lists the ultrasonic velocity in a variety of common materials. This is only a guide. The actual velocity in these materials may vary significantly due to a variety of causes, such as: composition, preferred crystallographic orientation, porosity, and temperature. For maximum accuracy, establish the sound velocity in a given material by first testing a sample of the material.

Material	**V (in./µsec)**	**V(M/S)**	**REF**
Alumina, $Al_2 0_3$ 99.5%	0.4013	10190	2
Aluminum, rolled	0.253	6420	1
Aluminum, 6061T6	0.251	6383	2
Beryllium	0.5073	12890	1
Brass, yellow 70 Cu, 30 Zn	0.1850	4700	1
Brass, yellow 70 Cu, 30 Zn	0.1726	4385	2
Copper, rolled	0.1972	5010	1
Duraluminum, 17S	0.2487	6320	1
Fused Silica	0.2349	5968	1
Fused Silica	0.2335	5932	2
Glass, crown	0.2008	5100	5
Glass, flint	0.1567	3980	5
Glass, pyrex	0.2220	5640	1
Iron, Armco	0.2345	5960	1
Lead, rolled	0.0771	1960	1
Lucite	0.1055	2680	1
Magnesium, drawn annealed	0.2270	5770	1
Molybdenum	0.247	6250	3
Monel	0.2105	5350	1
Nickel	0.2377	6040	1
Nylon	0.1031	2735	2
Polyethylene	0.0705	1950	1
Polystyrene	0.0925	2350	1
Silicone Rubber RTV	0.0373	0948	4

Table 6 Sound Velocities of Various Materials (Longitudinal Wave Velocity)

Steel, low alloy	0.2259	5734	2
Stainless Steel #347	0.2278	5790	1
Titanium	0.237	5990	3
Tungsten, drawn	0.2129	5410	1
Uranium	0.133	3370	3
Water	0.0590	1498	5
Zinc, rolled	0.1657	4210	1
Zinc, extruded	0.1756	4460	2

Table 6 Sound Velocities of Various Materials (Longitudinal Wave Velocity)

References

1. Folds, D. L. “Experimental Determination of Ultrasonic Wave Velocities in Plastics, Elastomers, and Syntactic Foam as a Function of Temperature.” *Naval Research and Development Laboratory*. Panama City, Florida, 1971.
2. Fredericks, J. R. *Ultrasonic Engineering.* New York: John Wiley & Sons, Inc., 1965.
3. *Handbook of Chemistry and Physics*. Cleveland, Ohio: Chemical Rubber Co., 1963.
4. Mason, W. P. *Physical Acoustics and the Properties of Solids*. New York: D.Van Nostrand Co., 1958.
5. Papadakis, E. P. Panametrics - unpublished notes, 1972.

Appendix C – Glossary

Term	Definition
Acoustic Impedance	A material property defined as the product of sound velocity (C) and the material's density (d).
Acoustic Interface	The boundary between two media of different acoustic impedance.
Acoustic Zero	The point on the CRT display that represents the entry surface of the specimen.
Amplifier	An electronic device that increases the strength of a signal fed into it, by obtaining power from a source other than the input signal.
Amplitude	Referring to an indication on the CRT screen, the vertical height of an indication measured from the lowest to the highest point on the indication. In wave motion, the maximum displacement of the particles of the material.
Angle Beam Transducer	A transducer that transmits or receives the acoustic energy at an angle to the surface to set up shear waves or surface waves in the part being inspected.
A Scan	Pulse-echo format wherein the CRT display shows the pulse travel time in the horizontal direction (left to right) representing the corresponding sound paths. The vertical direction (bottom to top) displays the maximum value of the acoustic pressure echo amplitude received by the probe.
Attenuation	The loss in acoustic energy that occurs between any two points of travel. This loss may be due to absorption, reflection, or other factors.
Attenuation (M.L.A.)	The loss of sound pressure in a travelling wavefront caused by the scattering of some of the wave's sound pressure by the grain structure and/or porosity of the medium, and by absorption, a conversion of sound energy into heat.
Back or Backwall Echo	The echo received from the side of the specimen opposite the side to which the transducer is coupled. This echo represents the thickness of the specimen at that point.
Background Noise	Extraneous signals caused by sources within the ultrasonic testing system and the material being tested.

Term	Definition
Beam Index Point	The point on the base of an angle beam probe's wedge from which the sound leaves the wedge and enters the specimen.
B-Scan	A sectional representation (side view) of a test specimen, often performed in an immersion system. This can be in the form of a photograph or recorder display.
Cal Block Velocity	Calibration block velocity.
Couplant	A material (usually a liquid or gel) used between the transducer and the test specimen to eliminate air from this space and thus facilitate the passage of sound waves into and out of the specimen.
Critical Defect	Either the largest tolerable defect or the smallest intolerable defect. The critical defect size is usually given by a specification or code.
Cross Talk	An unwanted condition affecting dual element transducers in which acoustic energy travels from the transmitting crystal to the receiving crystal by routes other than the intended path through the material.
Damping (Control)	A variable resistance across the pulser circuit output which shapes the excitation pulse. Typically it is used to change pulse characteristics to optimize either penetration (low damping) or near surface resolution (high damping).
Damping Material	Any gel, rubber-like substance, or other material which, when used in the transducer, results in a shorter ringing time of the piezoelectric crystal.
Decibel	A unit which compares levels of power. Two power levels P1 and P2, are said to differ by n decibels when: $n = 10 \log_{10}\left(\frac{P_2}{P_1}\right)$ This unit is often used to express sound intensity. In this case, P2 is the intensity of the sound under consideration and P1 is the intensity of some reference level. In the case of the displayed voltages on a cathode ray tube screen, the relationship becomes: $n = 20 \log_{10}\left(\frac{V_2}{V_1}\right)$

Term	Definition
Delay Control	Subcircuit of the sweep generator that allows a variably adjustable time period from the sending of the trigger pulse to the start of the sweep across the CRT.
Detectability	The ability of a test system (instrument and transducer) to detect a given size reflector.
Distance Amplitude Correction (DAC)	A method of flaw evaluation that uses a test block with a known size reflector at varying known distances from the transducer. This allows you to plot a curve on the CRT screen that represents the amplitude of that size reflector throughout a given distance range. This curve shows loss of energy due to beam spreading and attenuation.
Dual-Element Probe	A probe containing two piezoelectric elements, one that transmits and one that receives.
Dynamic Range	The ratio of maximum to minimum reflective areas that can be distinguished on the cathode ray tube (usually based on decibel ratios.)
Electronic Zero	The point in time when the pulser fires the initial pulse to the transducer and the point on the cathode ray tube screen where the electron beam leaves the baseline due to the initial pulse signal coming from the transmitter.
First Critical Angle	The minimum incident angle in the first medium at which the refracted longitudinal wave is eliminated from the test specimen.
Flaw	A discontinuity that may be undesirable but does not necessarily call for rejection.
Frequency	The number of complete cycles undergone or produced by an oscillating body in one second.
Gain	Used in electronics with reference to an increase in signal power, usually expressed as the ratio of the output power (for example, of an amplifier) to the input power in decibels.
Gain (Control)	Selects the amount of calibrated gain (dBs) available within the instrument. Usually consists of a coarse gain control (additions at 20 dB increments) and a fine gain (additions at 1 or 2 dB increments).
Gate	An electronic baseline display used to monitor portions of the displayed range with reference to distance or amplitude.

Term	Definition
Hertz	The derived unit of frequency defined as the frequency of a periodic phenomenon of which the period is one second; equal to one cycle per second. Symbol Hz. 1 Kilohertz (KHz) = 10^3 cycles per second. 1 Megahertz (Mhz) = 10^6 cycles per second.
Horizontal A	The smaller length (if rectangular) of the actual crystal. The software will compute the affective length automatically.
Immersion Testing	A test method, useful for testing irregularly shaped parts, in which the part to be tested is immersed in water (or other liquid) so that the liquid acts as a couplant. The search unit is also immersed in the liquid, but not in contact with the part being tested.
Incidence, Angle of	The angle between a sound beam striking an acoustic interface and the normal (that is, perpendicular) surface at that point. Usually designated by the Greek symbol α(alpha).
Indication	The signal displayed on the screen signifying the presence of a sound wave reflector in the part being tested.
Indication (Defect) Level	The number of decibels of calibrated gain that must be set on the instrument to bring the indication (defect) echo signal to peak at the reference line on the screen.
Initial Pulse (IP)	The pulse of electrical energy sent by the pulser to the transducer.
Leg	In angle beam testing, the path the shear wave travels in a straight line before being reflected by the opposite surface of the material being tested.
Linearity, Vertical or Amplitude	The characteristics of an ultrasonic test system indicating its ability to respond in a proportional manner to a range of echo amplitudes produced by specified reflectors.
Linearity, Horizontal or Distance	The characteristics of an ultrasonic test system indicating its ability to respond in a proportional manner to a range of echo signals, produced by specified reflectors, variable in time, usually a series of multiple back reflections.
Longitudinal Wave	Mode of wave propagation characterized by particle movement parallel to the direction of wave travel.

Term	Definition
Main Bang	Slang term used to describe the Initial Pulse Voltage.
Mode Conversion	Changing a portion of a sound beam's energy into a wave of a different mode due to refraction at incident angles other than zero degrees. In NDT, this usually involves conversion of longitudinal waves into shear waves or surface waves.
Peaking Up	Maximizing the height of any indication displayed on the CRT screen by positioning the main axis of the sound beam directly over the reflector.
Penetration	The ability of the test system to overcome material loss attenuation, that is, the ability of the sound beam to by-pass small reflectors such as grain boundaries and porosity in the specimen.
Piezoelectric Elements	A family of elements (such as lead metaniobate, quartz, lithium sulfate) that possess the characteristic ability to produce: a) voltage differential across their faces when deformed by an externally applied mechanical force, and b) change in their own physical configuration (dimensions) when an external voltage is applied to them.
Probe	Another name for a transducer or search unit.
Pulse Repetition Rate	The frequency with which the clock circuit sends its trigger pulses to the sweep generator and the transmitter, usually quoted in terms of pulses per second (pps).
Range	The distance represented by the entire horizontal CRT screen display.
Receiver	That circuit of a flaw detector that receives both the initial pulse voltage from the transmitter and the returning echoes (as voltages) from the transducer. By passing these incoming signals through certain subcircuits, the signals are rectified, filtered, and amplified with the results sent to the screen for display.
Reference Echo	The echo from a reference reflector.
Reference Level	The number of decibels of calibrated gain that must be set on the instrument to bring the reference reflector signal to peak at the reference line on the screen.

Term	Definition
Reference Line	A predetermined horizontal line (usually dictated by specifications) on the screen representing some percentage of total screen height (for example, 40%), at which reference echoes and indication echoes are compared.
Reference Reflector	A reflector of known size (geometry) at a known distance, such as a flat-bottom hole.
Refraction, Angle of	The angle of sound reflection in the wedge equal to the angle of incidence (also in the wedge.) The angle of reflectance is measured from the normal to the reflected sound beam.
Registration	The minimum detectable flaw size.
Reject (Control)	Also known as suppression, it limits the input sensitivity of the amplifier in the receiver. “Grass” or scattering noise can be reduced or eliminated from the screen by its use. On most analog instruments, it also destroys the vertical linearity relationship between echo heights.
Resolution	The ability of the test system (instrument and transducer) to distinguish reflectors at slightly different depths.
Scanning Level	The number of dBs of calibrated gain above the reference level added to insure seeing potentially significant reflectors at the end of the V-path in a weld inspection.
Second Critical Angle	The minimum incident angle in the first medium at which the refracted shear wave leaves the body of the test specimen.
Sensitivity	The ability of the test system (instrument and transducer) to detect a given size reflector at a given distance.
Signal-to-Noise Ratio	The ratio of amplitudes and indications from the smallest defect considered significant and those caused by random factors, such as grain scattering or instrument noise.
Single Element Probe	A probe containing only one piezoelectric element, which is used to both transmit and receive sound.
Skip-Distance	In angle beam testing, the surface distance that represents one V-path of sound in the material.

Term	Definition
Sound Beam	The characteristic shape of the ultrasonic wave sent into the material.
Sound Path Distance	The distance from the transducer beam index point to the reflector located in the specimen, measured along the actual path that the sound travels. Sometimes referred to as angular distance in angle beam testing.
Straight Beam Probe (Normal Beam Probe)	A probe that transmits the sound into the material perpendicular to the entry surface.
Surface Wave	Mode of wave propagation characterized by an elliptical movement of the particles (molecules) on the surface of the specimen as the wavefront moves forward, this movement penetrating the specimen to a depth of one wavelength.
Through Transmission	A test method in which the vibrations emitted by one search unit are directed toward, and received by, another search unit. The ratio between quantity of vibration sent and received is a measure of the integrity or quality of the material being tested.
Time Varied Gain (TVG)	Circuit that automatically adjusts gain so that the echo amplitude of a given size reflector is displayed at a constant screen height regardless of the distance to that given size reflector.
Transducer	A device that transforms one form of energy into another.
Transmitter	Circuit of the flaw detector that sends the initial pulse voltage to both the transducer and receiver.
Ultrasonic	Of or relating to frequencies above the human audible range, that is, above 20,000 cycles/sec. (Hertz).
Ultrasonics	Study of pressure waves, which are of the same nature as sound waves, but which have frequencies above the human audible limit, that is, above 20,000 cycles/sec. (Hertz).

Term	Definition
V-Path	The angular distance sound travels, measured from the top surface of the material to the bottom, and reflecting back up to the top surface.
Vertical B	The larger length (if rectangular) of the actual crystal. The software will compute the “affective length” automatically.
Wavelength	The distance between like points on successive wavefronts, that is, the distance between any two successive particles of the oscillating medium that are in the same phase. It is denoted by the Greek letter λ (lambda).

Appendix D – EPOCH LT Parts List

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Part	Description
EPLT-xx	EPOCH LT Flaw Detector

Table 7 EPOCH LT Ultrasonic Flaw Detector

Part	Description
EPLT/BAT	NiMH Battery
EP4/MCA-X	Mini Charger Adapter (“X”= Power Cord Configuration)
EPLT/CAL-NIST	NIST Calibration Certificate
36DLP/CC	Plastic Transport Case
36DLP/HAND	Hand Strap
EPLT/MAN	Instruction Manual
EPLT/OS	EPOCH LT Operating Software (exclusive of the interface program)

Table 8 Items Included with the EPOCH LT (Spares can be purchased)

Part	Description
EPLT/DAC	DAC (Distance Amplitude Correction)
EPLT/TVG	TVG (Time Varied Gain)
EPLT/DAC/TVG	DAC and TVG Combination
EPLT/MEM	Expanded Memory
EPLT/LPRF	Low PRF (30 Hz)
EPLT/RANGE	Extended Range 0.04” - 400” (1 mm - 10,000 mm)
EPLT/ECHO	Echo-to-Echo Measurement Software
EPLT/CSC	Curved Surface Correction
EPLT/AWS	American Welding Society Structural Welding Code

Table 9 Instrument Software Options

Part	Description
EP4P/IP-KIT-USB	EPOCH 4*PLUS* Interface Program (includes EP4P/IP, EP4P/C-USB-6)
EP4P/IP	EPOCH 4*PLUS* Interface Program (software CD-ROM only)
EP4P/C-USB-6	EPOCH 4*PLUS* and LT USB Cable

Table 10 PC Interface Program

Part	Description
EPLT/EW	Extended Warranty (One additional year)
36DLP-CC	Plastic Transport Case
EPLT/EC	External Stand-Alone Charger (base only)
PLUS/RPC	Rubber Protective Carrying Case (includes EP4/CH)
EP4/CH	Chest Harness for Rubber Protective Case
EPLT/DP	Screen Protective Screen Cover (Quantity 10)

Table 11 Optional Hardware Accessories

Documentation Comments

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Audience and Purpose					
Is the purpose of this manual clearly stated?	**1**	**2**	**3**	**4**	**5**
Does the document fulfill the purpose?	**1**	**2**	**3**	**4**	**5**
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Organization					
Do the instructions follow the exact sequence of steps?	**1**	**2**	**3**	**4**	**5**
Is the organization appropriate and logical at all levels?	**1**	**2**	**3**	**4**	**5**
Are the headings specific and helpful?	**1**	**2**	**3**	**4**	**5**
Is the Table of Contents complete and useful?	**1**	**2**	**3**	**4**	**5**
Content					
Do explanations enable readers to understand what to do?	**1**	**2**	**3**	**4**	**5**
Do notes, cautions, or warnings appear whenever needed, in the appropriate place?	**1**	**2**	**3**	**4**	**5**
Is everything accurate?	**1**	**2**	**3**	**4**	**5**

Are the main points properly stressed?	**1**	**2**	**3**	**4**	**5**
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Is the reading level appropriate to the audience?	**1**	**2**	**3**	**4**	**5**
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Is terminology consistent?	**1**	**2**	**3**	**4**	**5**
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Do the illustrations contribute to the usefulness of the document?	**1**	**2**	**3**	**4**	**5**
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Which topics are not covered that you would like to see covered in the next revision?

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